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MACCOY'S PNEUMATIC TOOL.

[*Report of the Committee on Science and the Arts.*]

[No. 1478.] HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, May 28, 1889.

The Sub-Committee of the Committee on Science and the Arts, constituted by the FRANKLIN INSTITUTE of the State of Pennsylvania, to whom was referred, for examination,

MACCOY'S PNEUMATIC TOOL.

Report that: This invention consists in an automatic hammer reciprocated in a cylinder by compressed air or by steam, and delivering a rapid succession of blows upon a tool-holder, into which are inserted suitable bits or chisels for cutting wood, metal or stone; and embraces in its details valves for admitting and exhausting the air, a provision for relieving the cylinder and piston from injurious friction and for cushioning the piston and holding the bit-socket in posi-

tion to facilitate its easy and steady application to the work. As exhibited to the committee, it was working at a very high speed, from the pitch of the sound probably more than five thousand strokes per minute. (*Figs. 1–7.*)

The instrument, as complete and connected ready for action, appears in the form of a short cylinder, having a flexible tube centrally connected to one end, through which compressed air or steam is supplied at a pressure of about forty pounds per square inch, and centrally at the other end, a guide or sleeve, in which the tool-holder reciprocates; into the socket of the tool-holder the cutting bits, chisels or hammers are inserted.

Upon disengaging a latch by pressing a button, the ends of the cylindrical case can be unscrewed, and inside of the shell or cover is found a working cylinder, with grooves on its outer surface and passages leading from the flexible tube at the centre of the upper cylinder head to one slotted chamber in the outside of the working cylinder and terminating in inlet ports leading into the interior of the working cylinder.

Another slotted chamber in the external surface of the working cylinder leads from reduction ports through the cylinder and terminates in a channel leading to the atmosphere through the head of the cylinder.

The piston is made long and fits fluid-tight, but with a minimum of friction in the cylinder.

In the piston, but working transversely through it, is a piston valve which is worked by the pressure of air admitted through the port in the side of the cylinder and exhausted through other ports in the same manner as the piston valves of some steam pumps, the proper ports in the cylinder being covered and uncovered by the motion of the piston. The valve consists of a cylindrical plug having two grooves formed therein with a collar between them, and fits in a cylindrical transverse seat in the piston and covers and uncovers, at proper intervals, admission and exhaust ports leading to the ends of the working cylinder.

The piston is not attached or connected to the tool-holder, but strikes upon it as a ram or hammer; a spiral

spring placed around the tool-holder, and resting with one end on a shoulder in the guide, and with the other end on a shoulder in the tool-holder, serves to retract the tool-holder; the upper end of the tool-holder has an expanded head, fitting loosely in the head of the working cylinder and receives the blows or strokes of the piston.

As the piston rises and falls in the cylinder it closes the ports and incloses a portion of the air between it and the ends of the cylinder, and thus forms an elastic cushion and relieves the operator of the shock of reversing the motion of the piston.

The piston is surrounded constantly by a film of air under pressure, and whilst not leaking appreciably, seems to sustain little or no wear, notwithstanding the rapid motion.

The effect of the rapid and short strokes on cutting tools upon stone, wood and metal, is to produce a smoother surface than has heretofore been practicable with chisels, and with a celerity unapproached by other means. It has a capacity to reach into angles inaccessible to rotative tools.

It has been applied successfully to the caulking of steam boilers, the chasing of silverware, *repoussé* work, stone dressing and sculpture.

The discovery of a new, rapid and cheap method of cutting and forming stone and metal, and the perfection of an apparatus to successfully apply it in the arts is, in this case, the real invention.

The invention is the subject of letters-patent of the United States, No. 373,746, November 22, 1887, granted James S. MacCoy for the new method, and United States letters-patent, No. 205,619, dated July 2, 1878, granted Samuel W. Dennis for a motor for dental pluggers, and United States letters-patent, Nos. 323,053 and 326,312, respectively, dated July 28, 1885, and September 15, 1885, granted to James S. MacCoy for his pneumatic tool.

As applied to caulking and chasing, and forming sheet metal, it surpasses in both ease and rapidity of work and perfection of finish all other implements; and as a practically useful machine, with a wide range of applicability in

the arts, it commends itself as deserving of the highest recognition as a valuable improvement.

Having in view the high claim which this invention has by its demonstrated utility, your committee deem it expedient for a clear understanding of the invention, that the prior state of art under which it is introduced should be examined and reported upon.

In investigating into this part of the subject, your committee have made an examination of the entire classes of inventions known as rock drills, pneumatic drills, steam hammers and pneumatic pluggers, as exemplified in the drawings of the United States letters-patent from the earliest to the present time, and have made selections of such as throw light upon the subject, which they submit in chronological order, in an appendix to this report.

In them they find isolated parts of the invention, but do not find the combination which produces the perfected result demonstrated by Mr. MacCoy's invention.

First of these is James Nasmyth's steam hammer. patented April 1, 1843, No. 3,042. This, whilst showing a cushion below the piston and a spiral spring above it, shows the ram with a long and slow stroke permanently attached to the piston rod, and in this respect differs radically from MacCoy's device (*Figs. 8–10*).

Bannister and Green's United States patent, No. 71,950, dated December 10, 1867, shows a double-acting piston, operated by compressed air and directly attached to a plugging tool-holder for compacting the gold foil in plugging teeth. In this device the plugging tool must move the entire length of the piston stroke (*Figs. 11–14*).

In both of the devices above noticed, the valve for controlling exhaust and inlet of the propelling fluid is a separate piece from the piston and receives motion therefrom only at intervals by a connecting mechanism.

In David Joy's United States patent, No. 80,550, dated August 4, 1868, for steam hammers, the admission and exhaust valves and passages are formed in the hollow piston rod, which rod is permanently attached to the ram (*Figs. 15, 16*).

E. A. Hyde's United States patent No. 91,349, dated June

29, 1869, for dental pluggers, shows a piston fitted to reciprocate in a cylinder, in one end of which is fitted and held elastically a guided tool-holder and which the piston and connected ram strike, the reciprocating motion of the piston being produced by the rapid reciprocation of an air syringe or valveless single-acting pump, which, through a flexible tube alternately forces air into and withdraws it from the same cylinder, apertures being made in the cylinder below the ram to permit outside air to enter on the return stroke. In this device the speed is limited by the slow action of the air column in the elastic tube (*Figs. 17, 18*).

Geo. F. Green's United States patent, No. 88,290, dated March 30, 1869, shows the Bannister and Green device of 1867, improved by the severance of the tool-holder from the ram and the addition of a valve operated by the piston of the ram to work the double piston valve controlling the admission and exhaust of air to the ram cylinder (*Figs. 19, 20*).

Wm. Manson's United States patent, No. 152,391, dated June 23, 1874, shows a loose piston or ram worked by fluid pressure admitted above and below it in a cylinder having a tool-holder at its lower end. There is no returning spring, and no valve or valve-working mechanism (*Figs. 21, 22*).

Geo. W. Nichols' United States patent, No. 158,863, January 19, 1875, shows a cylinder containing a heavy piston or ram operated by air forced into each end alternately by a pair of bellows, connected to the cylinder by flexible tubes and worked by a tilting treadle. In this device the tool-holder is formed in the end of the ram cylinder itself and the entire cylinder, as well as the tool, partakes of the percussive action of the ram; the action of this device was therefore slow (*Fig. 23, 24*).

Geo. H. Reynolds' United States patent, No. 162,419, dated April 20, 1875, for a rock drill, shows a long piston working in a cylinder and operating an attached drill-holder; the piston in this device acts as a valve alternately to cover and uncover ports leading to the cylinder, and controlling the admission and exhaust. This in its functions resembles the valvular structure contained in MacCoy's cylinder, but is, from its construction, of slow and heavy operation, the

tool-holder being attached to the piston, and therefore incapable of as accurate guidance, or as quick reciprocation. It is here referred to only as an illustration of the valve-operating device (*Figs. 25, 26*).

S. W. Dennis' United States patent, No. 195,102, dated September 11, 1877, has a cylinder provided with grooves and ports, like MacCoy's, but instead of a cylindrical piston valve, a rectangular sliding valve in the piston (*Figs. 27–37*).

In I. M. Stebbins' United States patent, No. 203,667, dated May 14, 1878, the invention described in Hyde's United States patent, No. 91,849 of 1869, already referred to, reappears with a mere change of proportion of parts (*Fig. 38*).

Moreau and Dennis' United States patent, No. 205,289, dated June 25, 1878, shows the same invention substantially as Dennis' patent, No. 195,192 of 1877, already referred to, with two sliding valves in the piston, and corresponding grooves and ports in the working cylinder (*Figs. 39–49*).

S. W. Dennis' United States patent, No. 205,619, dated July 2, 1878, shows the same device substantially as his earlier patent, No. 195,102 of 1877, with the substitution of a cylindrical piston valve, like MacCoy's, for the rectangular sliding valve (*Figs. 50–60*).

Wm. H. Dibbles' patent, No. 211,652, dated January 28, 1879, shows a cylinder similar to Hyde's 1869 patent, with the exception that the holes beneath the piston are closed, and the piston is reciprocated by alternately exhausting and admitting air above it (*Figs. 61–64*).

W. Richman's United States patent, No. 213,134, dated March 11, 1879, for a dental plugger, shows the piston or ram working in a cylinder, with a valve and valve-seat, like Dennis' United States patent, No. 205,619, dated July 2, 1878, but placed lengthwise in the axial line of the piston (*Fig. 65*).

Beach and Arnold's United States patent, No. 245,433, dated August 9, 1881, shows a steam mining drill, in which a double-acting ram or piston operates a tool-holder, retracted by a helical spring, but without any provision for cushioning a recoil (*Figs. 66, 67*).

The patent of Samuel W. Dennis, No. 205,619, dated July 2, 1878, essentially anticipates that of MacCoy, and

possesses most of its features and capabilities, but had for its object to provide a motor or instrument for dental use only, while the invention of MacCoy consists in so perfecting the details, and proportioning the parts as to render possible the use of the tool in various arts and for numerous purposes already mentioned, which had not been dreamed of by previous patentees. The novelty does not lie in the mechanical functions of the tool, but in the perfection of its details and proportions, and particularly worthy of recognition is his bold conception of its possible applications, and the persistent efforts by which these applications have been successfully made.

The real nature of MacCoy's invention is well expressed in the following quotations from his patent No. 373,476, November 22, 1887:

"After the purchase of, and three years' costly experiments with, other patents most like the foregoing, together with my own inventing, I finally attained success mainly by securing an unprecedentedly high rate of speed (estimated as high as 15,000 strokes per minute) which could not be made by former machines and which unexpectedly permits the use of thinner-edged tools than could be used heretofore. These ends have been secured mainly by so changing the proportions and adjustments of the valve and parts as to give the striker a very short and an exceedingly rapid stroke and by making the striker and its metallic cylinder with an appreciable difference in their diameters, thus forming an air chamber around the striker, whereby an enormously rapid practically continous action is attained.

"No one has ever before planed marble or metal with a stroke machine so far as I can learn. The successive strokes of the bit or tool are so very rapid that there is not time between them for the tool to rebound or quit contact with the material; and furthermore when each stroke does work, and thereby imparts mechanical energy, the tendency or ability to rebound has departed from the tool with that energy, and the tool thus makes a practically continous progressive movement and planes the material, a

result not accomplished by any machine heretofore patented or constructed."

The invention is expressed tersely and aptly in the claim:

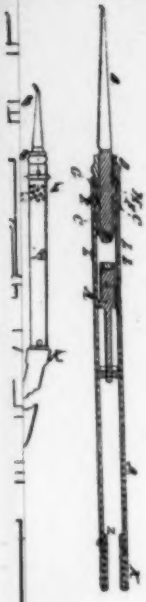
"The method of making a smooth surface on stone, metal or other hard substance by means of a reciprocating stroke machine, whose action is so rapid as to be practically continuous."

In conclusion, your committee deem the invention deserving the award of the John Scott Legacy Premium and Medal and respectfully recommend the same.

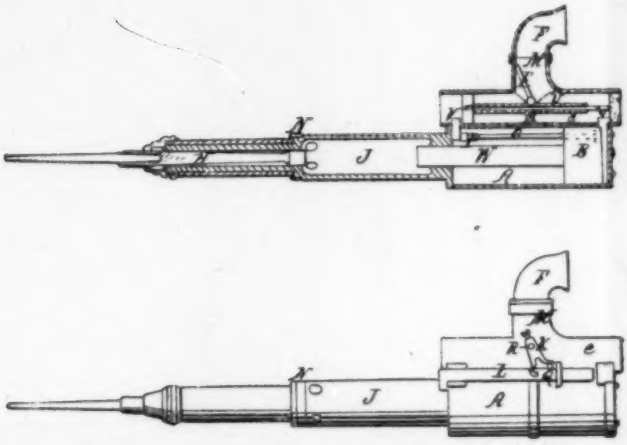
[Signed] LUTHER L. CHENEY,
Chairman Sub-Committee.
C. CHABOT,
N. H. EDGERTON,
JOHN HALL,
WM. C. HEAD,
ELI T. STARR,
WM. H. THORNE,
S. LLOYD WIEGAND.

Adopted, June 5, 1889.

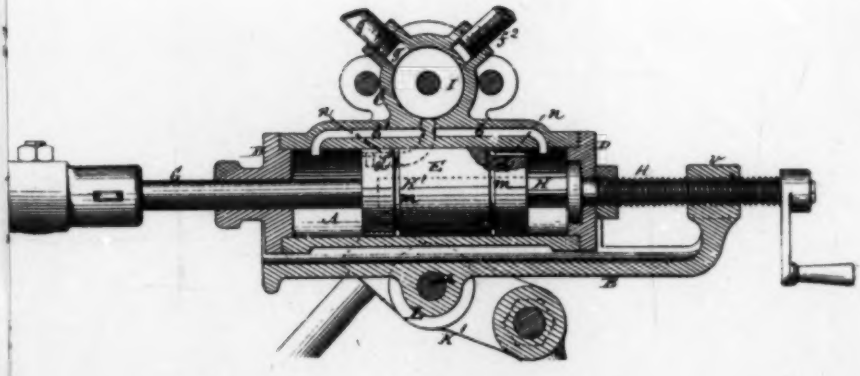
[Signed] S. LLOYD WIEGAND,
Chairman of the Committee on Science and the Arts.



1869.



FIGS. 19, 20. Geo. F. Green (No. 88,290), 1869.



25, 26. Geo. H. Reynolds (No. 162,419), 1875.

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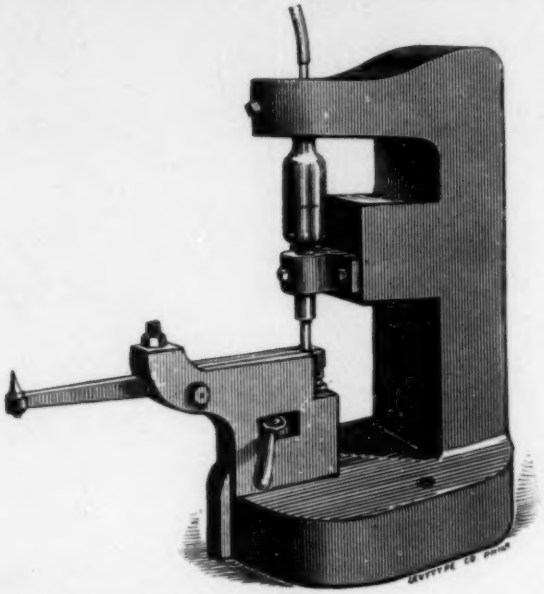
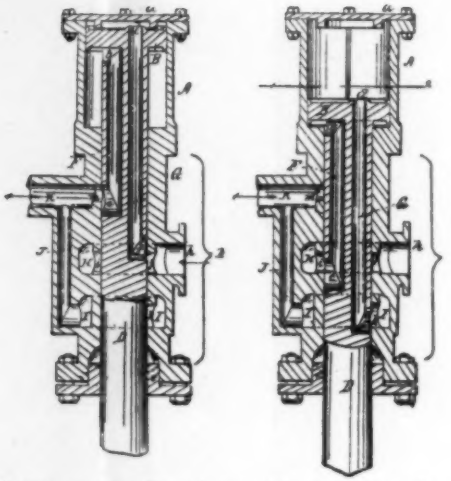


FIG. 7. James MacCoy's Repoussé Machine.



FIGS. 15, 16. David Joy (No. 80,550), 1868.

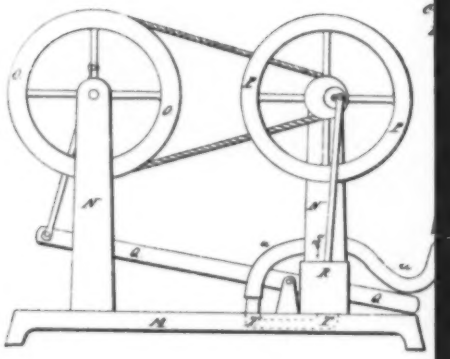
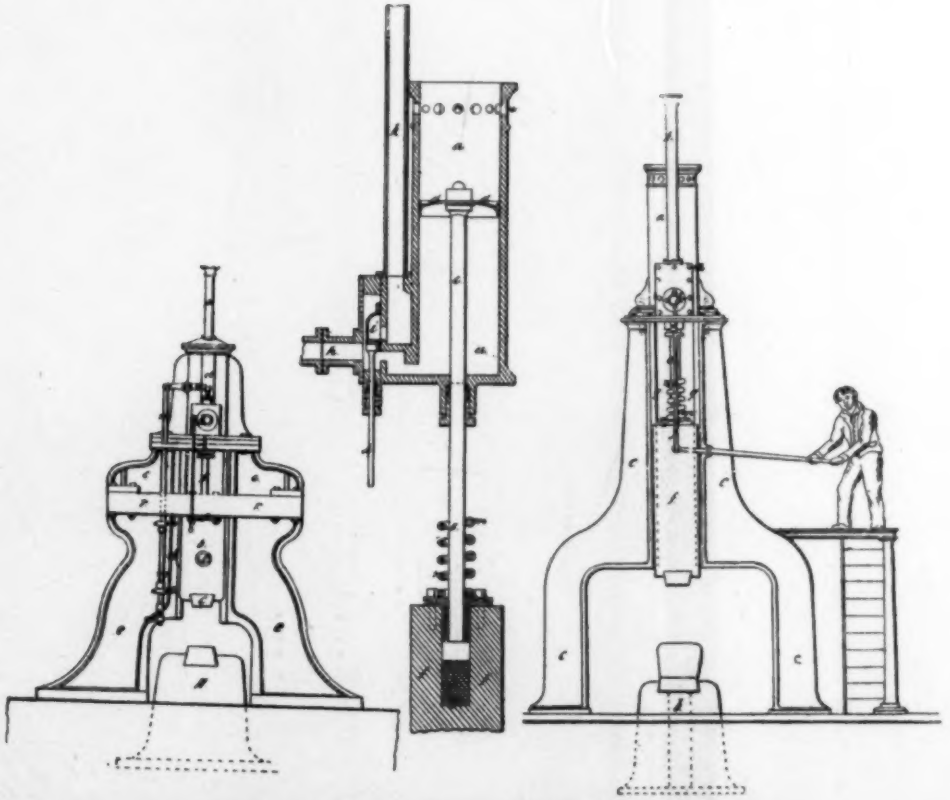
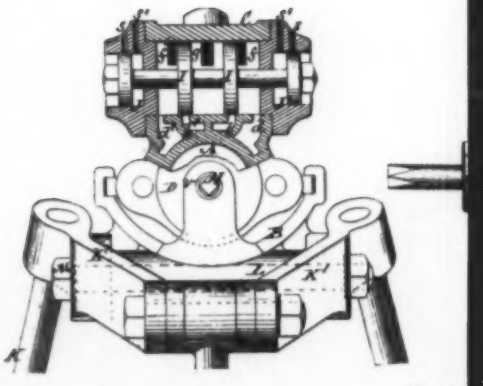


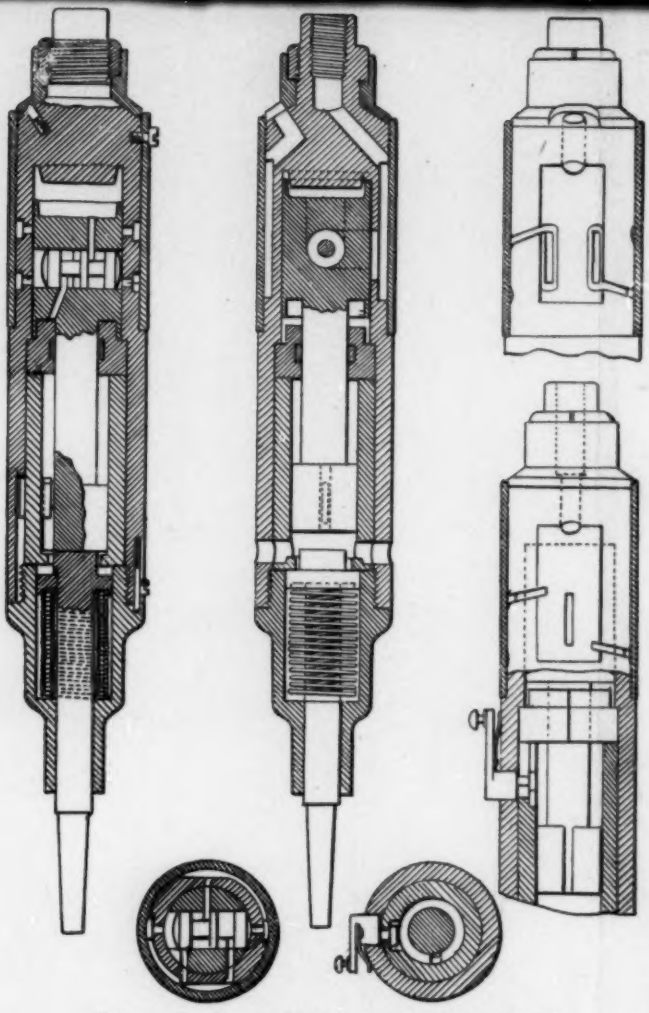
FIG. 17. E. A. Hyde (No. 91,849).



FIGS. 8, 9, 10. James Nasmyth (B. P. No. 3,042), 1843.

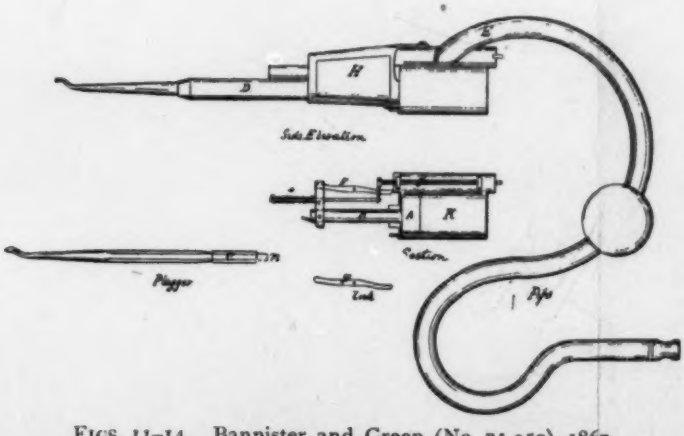


FIGS.

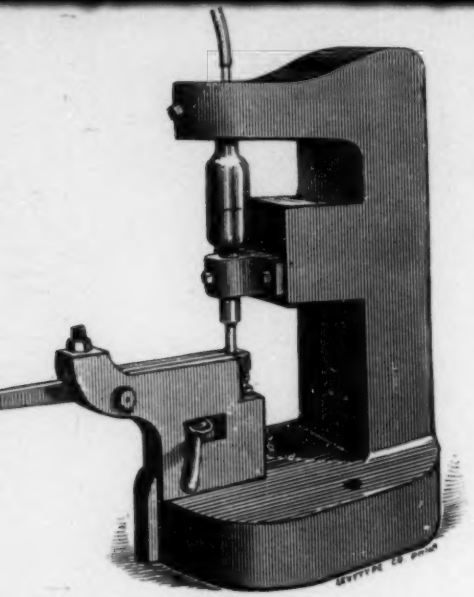


FIGS. 1–6. James MacCoy's Pneumatic Tool.

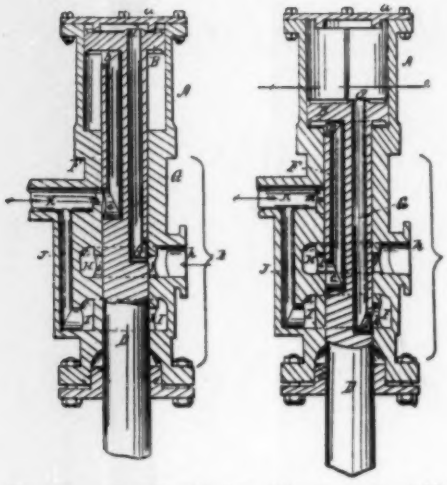
FIG. 7. James



FIGS. 11–14. Bannister and Green (No. 71,950), 1867.



IG. 7. James MacCoy's Repoussé Machine.



FIGS. 15, 16. David Joy (No. 80,550), 1868.

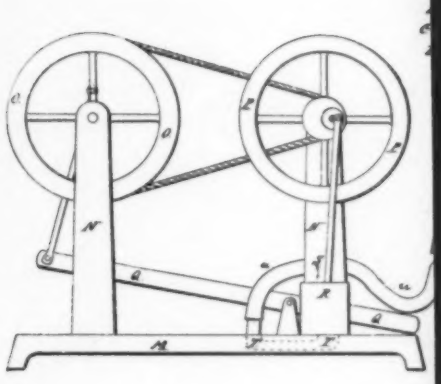
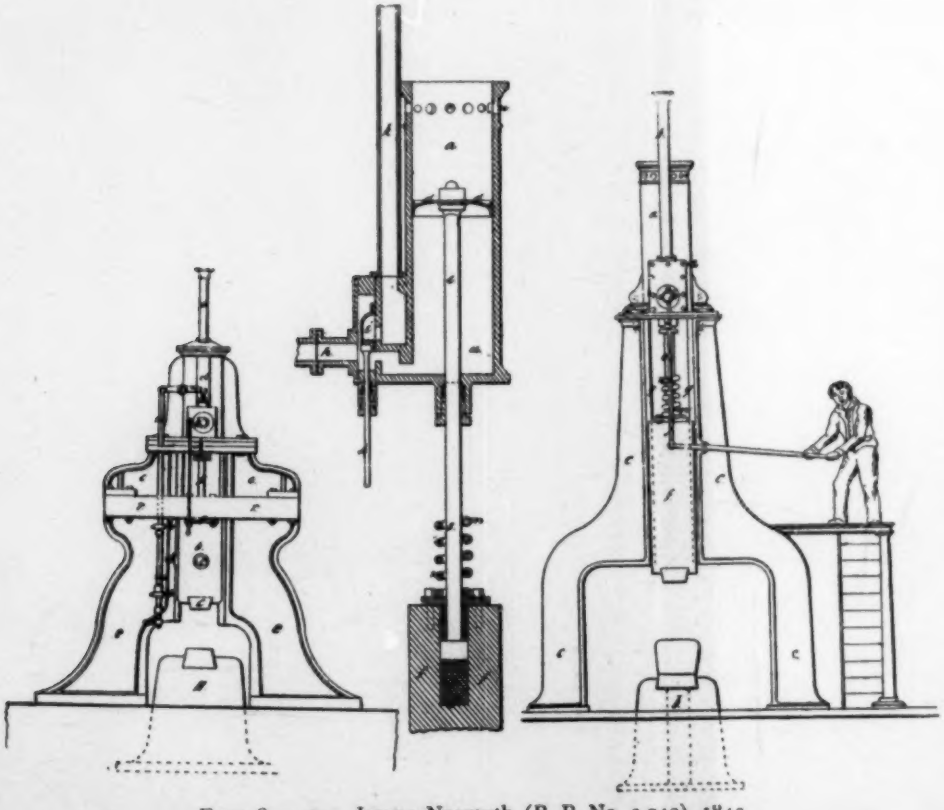
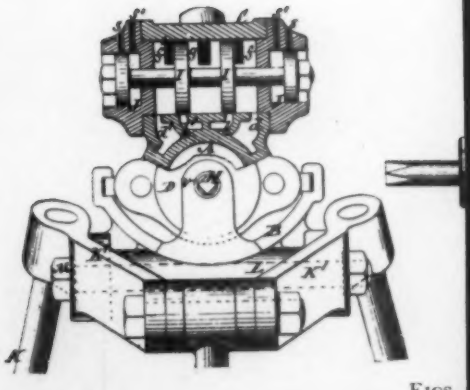


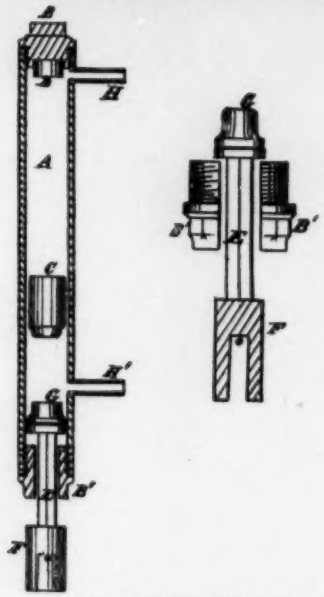
FIG. 17. E. A. Hyde (No. 91,849),



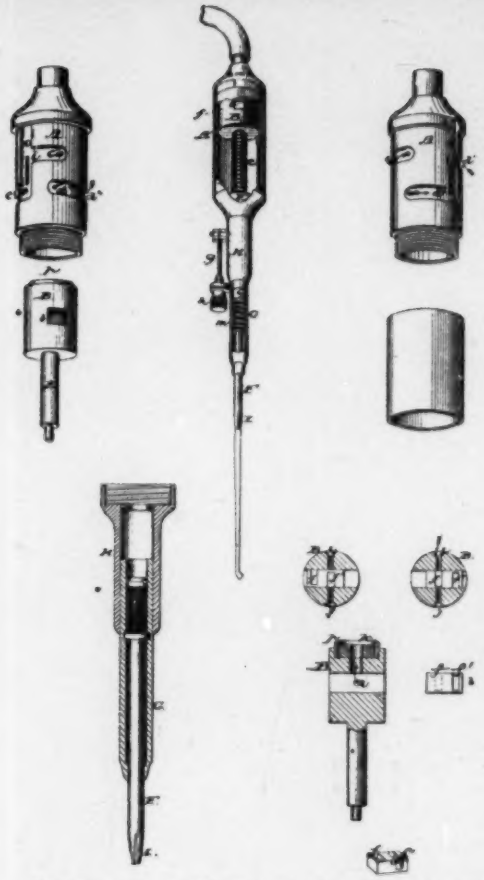
FIGS. 8, 9, 10. James Nasmyth (B. P. No. 3,042), 1843.



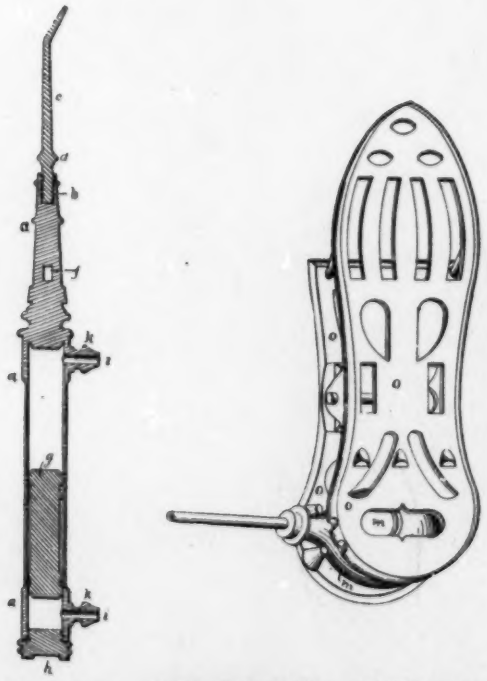
FIGS.



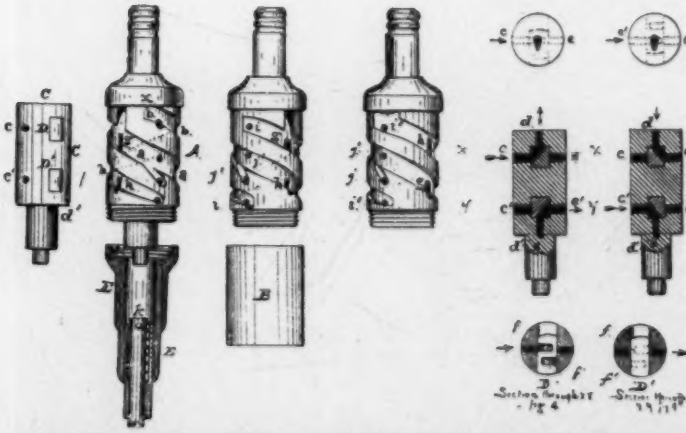
FIGS. 21, 22. Wm. Manson (No. 152,391), 1874.



FIGS. 27–37. S. W. Dennis (No. 195,102), 1877. FIG. 38.

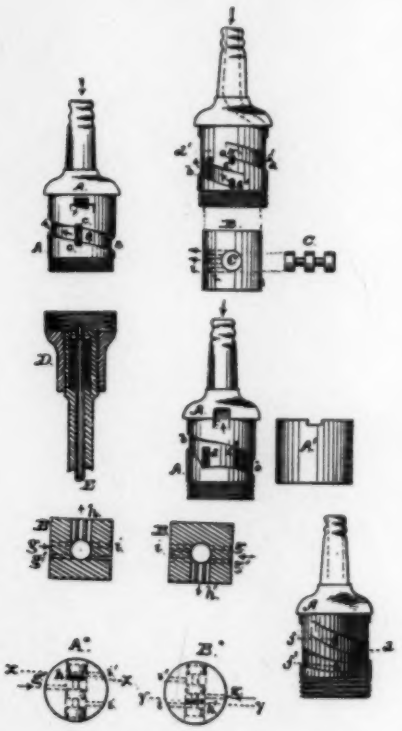


FIGS. 23, 24. G. W. Nichols (No. 158,863), 1875.



FIGS. 39–49. Moreau and Dennis (No. 205,289), 1878.

FIG. 38. I. M. Stebbins (No. 203,667), 1878.



FIGS. 50–60. S. W. Dennis (No. 205,619), 1878.

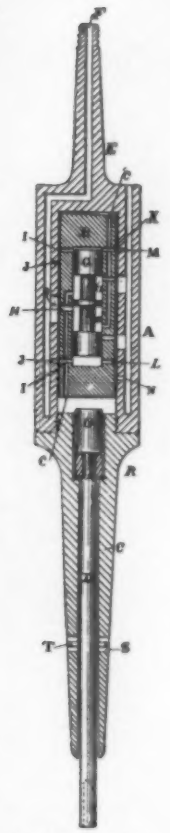
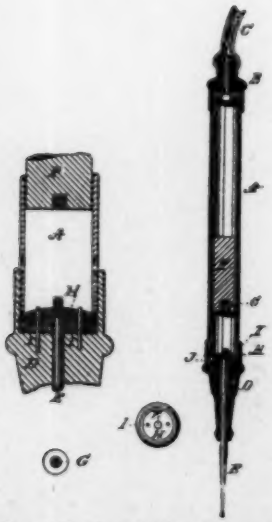
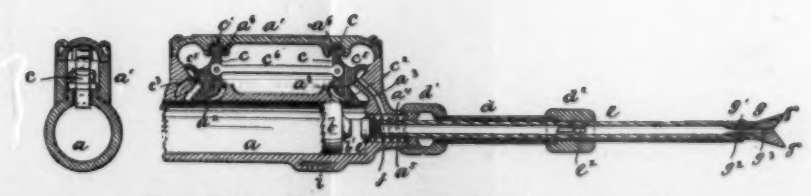


FIG. 65. W. Richman (No. 213,134), 1879.

), 1878.



FIGS. 61–64. W. H. Dibbles (No. 211,652), 1879.



FIGS. 66, 67. Beach and Arnold (No. 245,433), 1881.

BLINDNESS AND THE BLIND.

By L. Webster Fox, M.D.

[*A lecture delivered before the* Franklin Institute, *February 25, 1889.*]

(*Concluded from vol. cxxvii, page 437.*)

The second condition of defective vision and that which Americans should be careful to guard against, and yet are almost criminal in neglecting, is *myopia*, or *near-sightedness*. Civilization seems to be responsible for this increasing malady. Let any number of savages be tested for distant vision and mark the result—perfect vision. Transfer your examinations among the highest class of intelligence, or the book-worms and note the change—near-sightedness. Sift the statistics of Cohn, Risley and Darby. They tell us that myopia is rapidy on the increase among school-children. This means that as generation follows generation visual defects will also multiply. When Dr. Cohn, of Breslau, examined the eyes of 10,000 children, 1,000 were near-sighted. He found also, what was more important, that the number increased, as he ascended the schools from the primary to the higher classes. Bad light, badly constructed desks, both agencies being alike in causing children to stoop over their work. Then again, ten hours a day is much too long for a growing boy or girl to be harnessed to such close work. A director in one of the public schools recently brought his daughter to me to be examined for defective vision. I found that the child had so many lessons to write and commit to memory that she had two sets of books, one set remaining at home, the second set at school. The aggregate number of books were so many that she was unable to carry them. When school directors permit such a state of affairs, nature must succumb under the strain. Extreme cases of near-sightedness are always in danger of becoming blind by excessive eye strain; the inner coats of the eye separating and floating about in the vitreous fluids. Parents and teachers have a great responsibility resting upon them. They should see that children have proper glasses and should never allow them to assume

cramped positions, as stooping forward fills the blood vessels, and long continuance of this brings about changes which are hurtful to vision. Reading by moonlight, or defective artificial light, or in railway cars, is also a great source of evil. The pleasure a near-sighted person first experiences when using the proper glasses, is beyond description. I remember an instance of a general, who, during our late civil war, acquired a reputation for bravery in the field of battle far beyond what he deserved, as he expressed it years afterwards when he had his near-sightedness corrected by glasses. He found that his bravery was due to defective vision, not being able to see danger. Myopia was the making of his reputation, although many lives were lost, for no doubt he frequently led his men into danger, where, had he had good vision, he would never have ventured.

Having now explained the condition of visual defects brought about by either too short or too long measurements of the eyeball, I must dwell briefly on that condition of the eye where but one meridian is affected. It seems that this affection is more pronounced in the American type than in other nationalities. Not that it does not exist abroad, but our oculists probably are keener in its detection. I mean astigmatism. This defect may be far-sightedness or near-sightedness, or a combination of both. It comes from an eye whose focusing power is less in one meridian than in the other, or the curvature of the cornea is different in the two meridians. It is probably the source of more headaches than all the other visual defects combined. In looking at a card upon which radiating lines diverge from a point, its first and most obvious effect is to produce differences. Some may be perfectly clear and those at right angles blurred. In reading or drawing, one suffering with such a defect soon exhausts his vision.

Dr. R. B. Carter relates an anecdote of a gentleman suffering from astigmatism, or from what the patient described as, "periodical obscuration of vision." Dr. Carter found that the gentleman sat in an office which commanded a view of a large clock dial on the other side of a quadrangle. When the hands of the clock were approximately

vertical, he would see them plainly, but when they were approximately horizontal he could scarcely see them at all. The patient naturally thought he was a "curious physiological phenomenon." Glasses corrected the defect. Many students of Hebrew labor under this gentleman's mistake, the Hebrew characters being more pronounced in their horizontal lines. A clergyman once came under my notice who could not see lines running in a horizontal meridian. He was obliged to give up the study of Hebrew while a student at college. I have often been struck by the thought that probably the astigmatic eye might be held responsible for the peculiar formation of the letters of the different alphabets. If we examine the Hebrew type we find the horizontal lines much broader, while the German type is broader in the vertical. The Roman and Greek alphabets must have been invented by individuals with almost perfect vision, for these letters are the same in their different meridians.

Policemen and candidates for the fire department are subjected to a thorough physical examination at the hands of police surgeon Dr. T. H. Andrews. It falls to my province to examine them for defective vision and color-blindness. The examination of at least one thousand men show the defects of vision and lack of color sense to be exceedingly high. It is with pride that I can record the unwritten history of the good and efficient work done in this matter by our city officials. Men who readily pass an examination by daylight, might still have a defect which would render them incapable of doing duty at night. I may mention the case of one man, who held an appointment of trust, whose vision was good for his daily duties, but as soon as the twilight came on was so blind that he became helpless. This disease extended to sixteen members of his family, the result of a consanguineous marriage. How could such a man detect a burglar or the beginning of a fire in which hundreds of thousands of dollars might be lost? We now know the importance of having our "guardians of the night" equipped with perfect vision. This defect of night blindness, or nyctalopia, shows itself in two ways,

first by dimness of vision at night, and second by contraction of the field of vision, *i. e.*, an object which could be seen in the normal eye at the extreme right or left, the eye looking forward, would have to be brought to the front, approaching the middle line. A patient once graphically expressed the condition by saying that her eyes seemed to be gradually growing smaller.

Cataract is less clearly understood by the laity than almost any of the common affections of the eye. One invariably hears it described by individuals as a skin covering the sight. As the human being advances in years, we find the tissues contain less fluid, that the finger-nails, cartilages and bones become more mineralized, and so with the crystalline lens of the eye; it also takes upon itself a change. This change assumes a hardening and a consequent loss of transparency. As the lens is placed directly over the visual line, sufficient light cannot pass through the pupil, and the result is blindness. A certain amount is able to pass through an opaque lens. The light from a candle may be readily distinguished. When this is not so we find that the other parts of the eye have lost their functions, and in such a case it would be useless to remove a cataract. The oncoming of age is not always responsible for the development of cataract. Some are congenital, others the result of the abuse of health, and again traumatism enters largely into their development. Men who are engaged in furnaces, watching the molten metal and not protecting their vision with proper glasses, are extremely liable to early cataract. As to the exact cause of senile cataract we are still in doubt. Why one man at forty should have a thoroughly ripe cataract, and another man at seventy should escape, pathology leaves us in doubt. The predisposition to cataract before the age of forty is small, after this period relatively common. The habits of a people have much to do with its development. In countries where much cheap wine is drank cataracts are common. Professor Mooren, of Düsseldorf, once said to me that we, in the United States, would never have a large number of cataracts until our people drank more wine. Opium smok-

ing is said to produce cataracts. It is a well-known fact that cataracts are common among the Turks. Statistics fail to give us any information in regard to the Mongolians. Children are born with them, but fortunately nature takes a little compassion on her unfortunates, and instead of causing the whole lens to become opaque, the nucleus is the part affected. When dilating an iris which covers such a lens, a certain amount of vision is gained, but the peripheral part of the retina is only stimulated and vision is very imperfect. In such cases we have a constant rolling of the eyeballs, as if the person were constantly trying to get better vision. I have at present under my care a young woman who had this congenital defect. A needle operation was performed, the cataract was totally absorbed, but, contrary to my expectations, she still uses the peripheral part of her retina to see objects, the macula, or that part of the normal eye which is the sensitive part, being disregarded. Five years ago, at the Germantown Hospital, I had brought to my attention a case of congenital cataract, in a colored woman about sixty years of age. This woman had been blind from birth. She was able to see light but not form. After the successful removal of a cataract from one eye and the bandages were removed, for the first time in her life she looked upon the earth. She was quite nervous, and was afraid to walk. She was not able to measure distance, and would reach after objects a long way off. After assuring her that she could walk, she was led to the window to look upon the trees and the outer world. A flock of sparrows excited her very much, and when told that they were birds would not believe it. In walking she had no conception of distance, and would walk against objects in her way. Bright colors pleased her. When she wished to know the name of anything, she closed her eyes and felt the object with her hands. She was then able to tell what it was. About a year afterwards I removed the second cataract, which was also successful, and to-day she is still in the hospital as an employé, and is able to perform her duties as a general servant. It is not my purpose to enter into a detailed account of the various operations devised for the

removal of an opaque crystalline lens. That would be a subject which would probably interest medical students or members of the profession only. History has noted the fact that the ancient Egyptians recognized this form of blindness and performed an operation. Celsus described and practiced the needle operation, which operation was the only one performed for nearly 1,700 years. Daviel, a French surgeon, devised the corneal incision about the beginning of the eighteenth century, although it seems probable that the Arabians were acquainted with this method long before. As ophthalmic science advanced, various forms of operations were suggested and carried out. Fashions, in operations, run in grooves, just as we see it on the fashion plates. A particularly dexterous surgeon will find that he is successful in one kind of operation. He may have a large following of students, these students will imitate their teacher, and so it is that certain operations are introduced and become popular. To-day the ophthalmic surgeon has again attempted the operation without removing a part of the iris. This operation will in time be superseded by another, as time rolls on. Since the discovery of cocaine, much dread of the removal of cataracts has been taken away. This drug, which was discovered partly by accident, has been one of the best adjuncts to ophthalmic science.

The eye is an index to health. Note the change upon that man or woman who has lost much sleep either by press of work, disease, or mental worriment. There you will always see the opaque, glassy eye, lacking expression, showing more than in any other way that nature is exhausted. To the trained and observing physician the eye is an index to the seriousness of a malady more potent than the pulse or respiration. Since the introduction of the ophthalmoscope many diseases of the nervous system, of the circulation, and brain, are detected in their incipiency. By the examination of the background of an eye, at times with an equal degree of certainty the expert can prognosticate the lease of life. Watch the change in that individual who seeks early repose, takes plenty of out-door exercise, is guarded in his diet, spurns alcohol, tobacco, and other

stimulants. Let the face be ever so inattractive that eye, with its marvellous clearness, will attract our attention. Who has ever seen an intelligent man or woman with an eye that did not reflect the polish of the brain. Take the wretch, hardened to all the finer feelings which might once have existed in his organization, long steeped in crime and infamy. Note the difference. When such dull eyes of intensely passionate natures are looked at, you see the "eyes of born devils in human shape." The man whose brain has been ravished by disease and has become insane has the wild weird look that only a Poe could describe. There are some individuals, when under excitement, whose eyes reflect the activity of their brain like a "flash of light on a rocky coast." It is said that the eyes of Gladstone, when in the midst of a grand oration, will assume a most unnatural brilliancy, light will almost flash from them. Rossi and Irving seem to have stored away in their eyes electrodes, which emit sparks of light when overcharged with nervous excitement.

One is frequently asked, which eye is the stronger, the gray or the black? You might ask with an equal degree of propriety, which class of individuals are the longer lived, the blonde or the brunette. Color does not seem to enter into the strength of the eye. Nature in her wisdom had to guard the delicate organization of the eye by throwing around it a coat of pigment which absorbed an excess of light, hence it is that the race of people living in the torrid zone are dark-eyed and dark-skinned, while those living in the temperate zones, or where the rays of light are not so intense, have less pigment.

As I stated in the early part of my lecture, it is the abuse of the sense of sight which leads to weakness. This law holds good to the gray or black eye. In speaking of the beauty of eyes, a recent writer's views are as follows: "The most beautiful eyes in the world are the clear gray, with large pupils, and iris which changes and darkens with feeling as from the shadow of a cloud. The steadiness, brilliance and susceptibility of such eyes are an index to the rarest intelligence, quick and acute, and the high

romantic sentiments in which some characters become passions. Truth, liberality, loyalty, are the vital breath of such spirits, but, alas, those eyes are not of the long-lived. Dust is over them before we can say we have known them for our own."

The eye as an index to character has been described by Paracelsus, in 1616, in the following words: "To come to the practical part and give proper signs, with some of their significations, it is to be remarked that blackness in the eye denotes health, a firm mind, not wavering and fearful, but courageous, true and honorable. Gray eyes generally denote deceit, instability and indecision. Short sight denotes an able projector, crafty and intriguing in action. A squinting or false sight, which sees on both sides, or over and under, certainly denotes a deceitful crafty person, not easily deceived, mistrustful, and not always to be trusted; one who avoids labor when he can, willingly indulges in idleness, plays usury and pilfering. Small, deep-sunken eyes, are bold in opposition, not discouraged, intriguing and active in wickedness, capable of suffering much. Large eyes denotes a covetous, greedy man, especially when prominent. Eyes in continual motion signify short or weak sight, fear and care. The winking eye denotes a loving disposition, foresight, quickness in projecting. The downcast eye shows shame and modesty. Bright eyes, slow of motion, speak the hero, great acts, one who is daring and feared by his enemies, yet cheerful and sociable."

The best preservative to eyesight is out-door exercise. Watch the lustre of the eyes of that young man or woman who has just had a gallop through the Park, or who has had an hour at lawn tennis. A cold bath every morning stimulates the circulation, and with an active bounding of the blood through the arteries assimilation and elimination brings about good results. Heated rooms, with poor illumination, is a very prolific source of weak eyes. Reading or writing with the light falling on the page and reflecting its rays into the eyes often brings about a spasm of the little muscles which govern the accommodation and the

result is to exhaust the eyes. The light should always come from behind the individual and fall obliquely over the left shoulder. People who indulge in over-feeding, are careless about clothing, travel with damp feet, or dine irregularly, all suffer sooner or later from defective vision. A habit quite common among fashionable ladies, to whom nature has denied a black or brown eye, is to seek the secrets of the chemist's shop and apply a weak solution of belladonna or homatropine to dilate the pupil and render the cornea more brilliant. Even the cologne bottle has been drained of its contents to give brilliancy to the eyes. Such habits are only to be spoken of to be condemned. Let the natural lubricant be the only cosmetic used. See that the tears are kept healthy by proper means and nature will then do her duty. Another source of injury to the eyesight is the indiscriminate use of glasses. Scarcely a day passes but the ophthalmic surgeon must pass judgment on from one to half-a-dozen pair of glasses which are shown him by his patients who have been allured to the shops of the enterprising opticians by the deceiving advertisement, "Eyes examined free," as if sight could be measured, as the cloth merchant deals with his goods—by the yard. The druggist who dispenses his drugs must be a qualified man. Is it less important that the man who deals with the most important sense should be less so? As the druggist is not a physician, so should the optician not pretend, by his practice, to be an oculist. I am sure that the note-book of every oculist is filled with cases showing where irreparable injury has been done by glasses improperly adjusted. I remember the case of a little girl who for several years was obliged by an over-zealous mother to wear glasses which were given her by an itinerant peddler for near-sightedness, when upon examination the child was found to be far-sighted. Many elderly people make a very grave mistake in submitting the care of their eyes to the same class of individuals.

When glasses must be changed more than once a year and the wearer is more than fifty years of age, there must be something wrong with the functions of the eye, and

while it may be only a signal of danger, yet that person should seek advice through the proper source. If ophthalmology is a science, then the making and prescribing of glasses are as different as the mixing and prescribing of drugs. We have before our Legislature a bill for the higher education of medical students. What a benefit would be conferred upon the community at large if a clause were added to that bill making it a misdemeanor to sell glasses without a prescription. The adjustment of glasses is a science as much dependent upon a scientific knowledge of the eye as the prescribing of drugs for symptoms which may be the forerunner of a serious malady. Within the last week I had to inform a young woman that she was hopelessly blind and that treatment would be of no avail. She had an affection of the optic nerve which, when it first made its appearance, caused dimness of vision. Thinking that a pair of glasses would remedy her failing sight, she sought aid at the hands of an optician who examined eyes free. She bought four pairs of glasses in as many months, receiving the assurance that it was only stronger glasses that she required. The law permits such wrongs, but the life of that young woman is condemned to utter darkness while life remains. In justice to some of our leading opticians I must say that they are exceedingly careful to whom and for what purpose they sell their wares. They may lose the sale of a dozen pairs of glasses, but what is that to the consciousness of knowing that they do not steal away the vision of individuals who, from their indigent circumstances, are the most to excite our sympathies. The Americans use their eyes as they do their brains and bodies. They condense as much labor into two score years as they should into three score and ten. Watch that boy going to school with a pack of books, whose weight has curved his spine before he has arrived at his fifteenth mile-stone. His eyes at this period of his life are overstrained, the result is, glasses must be brought into use to support a weakened condition of the muscles of accommodation. He grows into manhood weakened physically. Many men and women abuse the gifts given them by a prudent ancestry, by read-

ing through a forty column newspaper on a jolting railway train, or in a poorly-lighted street car, changing the focusing power with every foot of ground travelled. Our American journals, not content with giving a man a fair amount of reading for six days, double the dose on Sundays. The overworked business man needs as much rest for his eyes and brain, as the overworked laboring man for his muscles. The latter will prudently observe this one day. The business man must have his newspaper which, with its thirty pages of printed matter, must be read. Thus from Monday morning 'till Monday following his eyes and brain are kept constantly employed. This high pressure is going to show its effects sooner or later. Were it not for the new blood brought into our country by the peasants of Europe, which prevents our race from degenerating, I would not like to answer the question as to what would become of us as a race in a few generations. Education must be given to children, the fine arts cultivated, business must go on, but let us halt and think. We owe something to posterity. The greatest inheritance a child can have is a good physique, which also means good health. The care of the eyes in childhood is of the greatest importance. They are more sensitive to light then than in adult life. A mother or nurse will frequently expose the eyes of an infant to the glare of the sun for hours at a time. One can surmise the evil which will be the outgrowth of such carelessness. The greater number of the blind lose their sight from carelessness during infancy. When one visits a blind asylum and sees the number of children who could have been saved from their deplorable condition, one grows heartsick. Parents must remember that, as the child advances in years, a difference may exist in its eyes. As the child is father to the man, so do oculists know that the eyes in childhood are subject to as much variation in their power of seeing as in adult life. The eyeball of one child may be normal, in another either too short or too long. A variation from the normal means eye strain.

It has been found that near-sightedness largely exceeds far-sightedness of children in cities. We speak against the

early instruction of children. Seven to nine years of age is soon enough for children to begin their studies. By this time nature has acquired a certain development which can resist to some extent the amount of labor put upon an eye. Children should have good light during their study hours, and should not be allowed to study much by artificial light before the age of ten. Books printed in small type should never be allowed in school-rooms, much less be read by insufficient light. The selection of occupation for children should not be neglected. Examination for color-blindness should be gone into, visual defects searched out. How very unfortunate it would be for a boy who had given a certain amount of his student life to the study of an occupation which he could not follow. A boy might be able to see the time on the steeple of a tower half a mile away, yet not be able to follow a line in drawing for five minutes. An out-of-doors occupation in such a case might make him a successful man, while he would fail as an architect, no matter what his ability as an artist might be.

The eyes of the adult may suffer from any cause. Overwork, with insufficient light, is a prolific cause of trouble. Dr. Carter tells us that natural light is as necessary to the eye as food to the stomach. At one time it was the fashion to have houses made as gloomy as dark paper on walls could make rooms. Dark blinds, guarded by shutters painted in some dark color. When people so housed come forth into the natural light they remind one of a squinting race. All of this was a prolific source of eye trouble.

Writers on hygiene have the satisfaction of knowing that their condemnation is producing different effects in home decoration.

To those who are familiar with Beethoven's beautiful, and world famous "Moonlight Sonata," it must be a pleasure to know that it was inspired by a blind girl. The story is told by a friend of his, who accompanied him one evening on a walk through a narrow street in Bonn. While they were passing the door of a cobbler's shop, Beethoven suddenly stopped, and as his ear detected the sound of music said, "Hark, what sound is that? It is from my sonata in

F. How well it is played." They entered the room and found seated at the piano a blind girl, her brother near by repairing shoes. "Pardon me," said Beethoven, "but I heard music and was tempted to enter. I am a musician. I overheard something of what you said. You wish to hear some good—that is—shall I play for you?" There was something so odd in the whole affair, and something so comical in the manner of the speaker, that the spell was broken in a moment, and all smiled involuntarily. "Thank you," said the shoemaker; "but our piano is so wretched, and we have no music." "No music," echoed my friend; "how, then does the young lady—" He paused and colored, for as he looked in the girl's eyes he saw that she was blind. "I, I entreat your pardon," he stammered; "I had not perceived before. Then you play by ear?" "Yes," said the girl; "we lived at Bruhl for two years, and while there I used to hear a lady practicing near us. During the summer evenings the windows were open, and I walked to and fro outside to listen to her." She seemed so shy that Beethoven said no more to her, but seated himself quietly at the piano and began to play. He no sooner struck the first chord than I knew what would follow, how grand he would be that night. And I was not mistaken. Never during all the years I knew him did I hear him play as he played to that blind girl and her brother. He seemed to be inspired; and, from the instant when his fingers began to wander along the keys, the very tone of the instrument seemed to grow sweeter and more equal. The brother and sister were silent with wonder and rapture. The former laid aside his work; the latter, with her head bent slightly forward, and her hands pressed lightly over her breast, crouched down near the piano, as if fearful lest the beating of her heart should break the flow of those magical, sweet sounds. It was as if we were all bound in a strange dream, and only feared to wake. Suddenly the flame of the single candle wavered, sank, and went out. Beethoven paused, and I threw open the shutters, admitting a flood of brilliant moonlight. The room was almost as light as before, the moon's rays falling straight upon the piano and player. But the chain of his ideas

seemed to have been broken by the accident. His head dropped upon his breast; his hands rested upon his knees; he seemed almost absorbed in thought. He remained thus for sometime. At length the young shoemaker rose and approached him eagerly, yet reverently. "Wonderful man," he said in a low tone; "who and what are you?" "Listen," said Beethoven, and he then played the opening bars of the Sonata in F. A cry of delight and recognition burst from them both, and they exclaimed, "Then you are Beethoven!" They covered his hands with tears and kisses. He rose to go, but they held him back with entreaties. "Play to us once more, only once more." He suffered himself to be led back to the piano. The moon shone brightly through the window and lighted up the glorious rugged head and massive figure. "I will improvise a sonata to the moonlight," he said, looking up thoughtfully to the sky and stars. Then his hands dropped upon the keys and he began playing a sad and infinitely lovely movement, which crept gently over the instrument like the calm flow of moonlight over the dark earth. This was followed by a wild, elfin passage in triple time—a sort of grotesque interlude, like the dance of spirits upon the lawn. Then came a swift *agitato finale*—a breathless, hurrying, trembling movement, descriptive of flight, and uncertainty, and vague impulsive terror, which carried us away on its rustling wings, and left us all in emotion and wonder. "Farewell to you," said Beethoven, pushing back his chair and turning toward the door—"farewell to you."

HARBOR BAR IMPROVEMENTS.

By L. M. Haupt, C.E.

That the prosperity of a nation is measured largely by and dependent upon its commerce is proven by the history of the maritime countries of the world. Probably the most renowned instance on record is to be found in the astonishing growth of the Venetians in wealth, power and influence. Located in an out-of-the-way corner of the Adriatic, and surrounded by a labyrinth of islands and lagoons, Venice rapidly expanded from her straw-thatched huts to her marble palaces, while her navy defied the world for well-nigh fourteen centuries.

The ocean is the highway of nations, and her gateways are the ports which indent her borders. Where these portals are spacious, safe and unobstructed, there will commerce thrive, and the greater the number of such gateways, the more fully will both internal and international comity be developed.

The Nicaragua Canal, like her oriental sister at Suez, will be a diadem in the girdle of the earth, binding the East and the West, the North and the South, more closely together by thousands of miles, and thus hastening the time when the civilization and influence of the great Anglo-American commercial nations shall pervade the world.

"Peace hath her victories no less renowned than war," and such victories as these are most potent factors in removing the *casus belli.*

It is a well-known fact, however, that the unceasing forces of nature, the winds, waves, tides, and currents, aided by gravity, have bolted these gates by bars which have taxed the ingenuity of man for centuries to unloose; for man and his works are finite, but the sea is the work of the Infinite, and His forces endure through ages. If the barriers may not be removed, at least in part, or a pathway be opened through them, then must commerce and the nations

languish. Hence the momentous importance of the problem and the justification for the expenditure of millions in the attempt to solve it.

In making this attempt, however, it would seem to be necessary that judicious regard be paid to the lessons of experience, and that past failures should not be repeated under similar conditions.

The old world is full of instructive precedents as to the operation of the various systems which have been tested for generations, and the new world seems bent upon repeating these extravagant experiments, only on a grander scale.

According to the highest official authority in the United States, the methods available for the treatment of these important works for harbors on alluvial coasts are but two in number, namely, "by dredging alone, or by using tidal scour between jetties, aided, if necessary, by dredging. As to the first method, it has already been tried unsuccessfully." As to the second, the same authority states: "The jetties should be so placed as to secure the greatest tidal scour practicable without seriously injuring the interior harbor, and without greatly endangering the safety of the jetties against undermining, or of Galvestown Island from overflow in great storms. The greatest scouring effect will be obtained, and the greatest security against undermining, by making the jetties tight and by raising them above high water."*

These latter conclusions were only reached after a score of years had been spent in experimentation, at a cost of $4,576,337.12, and the result to date has been no increase of depth over the bar, but a hastening of the anticipated evils, so that to-day the total estimated cost of this single project is $8,478,000. After so great an outlay and the lapse of the years required to complete this work, what result may be predicted? The authorities say, "Such a jettied channel offers more resistance to inflow than does the present entrance; reduces the present tidal prism about one-third; allows the bay to fill more slowly than the present entrance does and

*Ex. Doc. No. 85. House of Representatives, Forty-ninth Congress, First Session. p. 13.

hence gives greater differences of level," and they add in closing their report, "The jetties will diminish the freedom of inflow at Galveston." In short they will violate the fundamental requirements of the greatest freedom of influx to the flood tide that there may be a full prism for the ebb scour, and yet with these admissions before them the people of the state of Texas, trusting to this forlorn hope, appeal urgently for the rapid completion of the project.

Is this the *dernier ressort* of the profession of engineering in this nineteenth century, and must we follow blindly the precedents of the middle ages, modified only by the materials of modern times? If so, there are few places, indeed, of sufficient importance as to justify the great expense required for annual dredging and maintenance.

The difficulties surrounding these questions, as seen by the Board of United States Engineers, are expressed in the following extracts from a report on one of the Texas passes:

"The problem of the improvement of the navigation of this pass is by no means an easy one. Some of the difficulties may be mentioned, viz., the want of stability in position of the pass itself; * * * the instability of the foundation on which any structure is to be built; the shifting sand of the Texas coast; the presence in the water in which any structure must be placed of the sea worm (teredo) in such activity that wood cannot be used except to a very limited and exceptional extent, if at all; the necessity of bringing stone, cement, etc., from long distances and at much expense; the heat and other discomforts of a tropical climate increasing the cost of labor." In suggesting a method of procedure the Board say, "The first step in the improvement is to adopt some means of checking the recession of the island which limits the pass on the western side. * * * As the work progresses experience will probably suggest variations of detail. There is a good prospect of success in deepening the channel by the use of two jetties. The locations for them, as recommended, are approved subject to such change as further study may show to be expedient."

Notwithstanding these exceptional difficulties the plan of jetties in pairs, founded upon brush mattresses, is adopted, yet the report bears inherent evidence of doubt as to method, location, material and results, in fact the day after signing it one of the most experienced officers of the Board writes: "I wish it to be understood that with the information now before me I believe one jetty *may* suffice at this locality." * * * "The views of (the officer in charge)* on the subject of the form in plan of jetties are clearly and strongly put, but I do not coincide in them entirely, either in general application or in particular at this locality."

The soundness of this opinion, which would reduce the cost of the work about one-half and increase the probability of securing deeper water, are based upon a few physical characteristics of this and other inlets. They are, the general direction of the resultant of the forces acting along this coast, which produces a gradual yet constant progression of the inlets to the south and west at the rate of about 200 feet per annum, and the flexure of the ebb channel, where it crosses the bar, in the same direction. These obstructions are not delta bars formed by the deposition of sediment from the interior drainage area, but are drift bars composed of beach sand rolled along by the waves and littoral currents, as affected by the incoming tides, and checked abreast of the opening through the outlying sandy cordon. The ebb currents being obstructed by the deposit are turned to the southward and effect their escape along the line of least resistance, which hugs the lee shore and has a direction nearly at right angles to that of the flood component.

Thus, the source from whence comes the sand forming the bar being known, the remedy would seem simple, and the first requirement would be to keep the sand out of the ebb channel by a suitable obstruction, which would not seriously oppose the free ingress of the tide.

The barrier must be placed between the source of supply and the channel. What must be thought then of a policy which invariably directs the construction *first* of the

* The writer has omitted names to avoid the appearance of personalities.

jetty on the farther side, where its effects are soon manifested by the large shoals created in the natural path of the ebb currents, and which they are obliged to roll on, if possible, into deeper water, thus pushing the bar seaward, adding to the ultimate cost, increasing the undermining of the work, and finally burying it under the original bottom? As well might a snow-fence be placed on the wrong side of a railroad cut to prevent it from filling with snow. These results are not idle speculations, but oft-repeated facts, proven by surveyors; for example, in a report on the jetty partially built upon the *south* side of one of the Texas inlets, the officer in charge says that "out of the total length of 5,253 feet of jetty constructed, about 775 feet, built upon shore, and constituting a root to the jetty rather than the jetty itself, has been well maintained; 1,710 feet has diminished in height from forty-seven to eighty-five per cent., and the remaining 2,768 feet (over half a mile) has practically disappeared. The trenches which have been formed at the sides of the portion of the work which remains, constitute a disadvantage in its further prosecution, which more than counterbalances the advantage of utilizing the material now in place. * * * It will be economy to abandon the present site and lay out a new line parallel with the present one and about 250 feet west of it." * * * "The lightness of the structure and the teredo are not sufficient to account for this. (The injury to the site.) Neither of these causes could have placed the mattresses where they are now found, below the original bottom and buried in the sand." * * * "It is possible, but not certain, that the work, when completed, will secure a depth of twelve feet over the bar." This experience cost $290,000 up to July 1, 1886, and it is estimated that the completed structures will foot up to $3,826,437.50.

All to secure a channel of possibly twelve feet depth while the natural depth varies from seven to thirteen feet. The proposition to rebuild 250 feet west of the former site would merely prove to be a repetition of the above experience.

At another of these inlets, where the normal depth varies

from seven to nine and one-half feet, and where $481,250 have been expended up to July 1, 1888, it is stated that "the effect of the work upon the bar has been insignificant." Here a jetty, having a total length of over a mile, was also built upon the south (the wrong) side of the pass, and was found to have settled over fifty per cent. along the outer half, while the northern jetty has not yet been begun for lack of funds. Had the jetty been built originally on the north side, and in proper form and position, the other would have been useless, and a marked improvement in the channel would have been the result.

This is shown by the temporary jetty constructed by private parties in 1869 at this pass at a cost of only $10,000. This jetty was but 600 feet long, and built of light, perishable materials, yet so long as it remained it increased to and maintained the depth in the channel at twelve feet, and as it was gradually broken up by the waves, the channel shoaled to its former condition.

Although this precedent was known to and reported upon by several of the engineer officers of this district, they failed to profit by the experience thus furnished. These works were, therefore, started wrong, and they have either wholly or partially disappeared.

Even in pursuance of the jetty system, it is admitted that "it is the history of all jetties that they will in time require extension. No plan should be followed which does not keep in view future extensions." * * * "If two jetties are to be built, they should be essentially parallel to each other." * * * And, again, "Whatever difference of opinion there may be as to how much depth will be secured by a single jetty, there can be none, I think, as to whether a greater depth will not be obtained by two."

Per contra, one of the highest English authorities in a comprehensive review of jetty harbors on the continent says: "The jetties also, in most cases, were extended in the hope of reaching deep water, which proved fruitless, owing to the progression of the foreshore with each extension of the jetties. Next, artificial sluicing basins were formed to provide a larger mass of water for sluicing, with the additional

advantage that the issuing current was nearer and better directed for scouring the entrance. Lastly, dredging with sand-pumps is being largely employed for deepening the channel beyond the jetties. The parallel system has not proved successful in providing a deep entrance without constant works. * * * Parallel jetty harbors are one of the most difficult class of harbors to design and maintain successfully. * * * Sluicing and dredging are the two means by which the entrance to these ports may be maintained and improved. They are both needed, as they possess distinct functions."*

Again, the President of the Institution of Civil Engineers, of Ireland, says: "The system so generally adopted in Continental ports, of parallel, or nearly parallel jetties, extending only to comparatively shallow depths, appears to be radically wrong in principle. Their tendency generally is to act as groins, and make the sandy shore extend outward until the sand passes around the pier-heads where the action of the sea heaps it up in the form of a bar."

Whilst there are a few instances of the success of parallel jetties, notably at the mouths of the Danube and the Mississippi, it will be observed that the bars at these points are delta-bars, that there is little or no tide, with no inner bays, and that, consequently, the ratio of tidal prism to fresh-water discharge is very small and by far the larger volume of flow is seaward. These conditions do not obtain where there are large interior bays or lagoons which must be filled at every tide to maintain the scour over the bar, and where every structure placed on the bar becomes more or less of an obstruction to the influx of the tide.

For this reason the dike proposed a few years since for the improvement of the entrance to New York Bay, and reaching from Coney Island in a south-southeast direction for about five miles towards Gedney's Channel, would, if built, have proven more injurious than beneficial. It was estimated to cost about $5,000,000.

The causes for the degradation of this most important entrance are the sands travelling northward along the

* *Harbors and Docks.* By Sir Vernon Harcourt, Oxford, 1885.

Jersey coast, and westward along the Long Island beach, with the flood tide. Thus the comparative surveys of Fire Island Inlet* show a westward progression of the shore line amounting to two miles in about fifty years. At Rockaway Inlet there is a similar movement, which is also observable at Norton's Point, the western extremity of Coney Island, but not to so great an extent, due to the eroding action of the ebb cross-currents from the upper bay.

On the other hand Sandy Hook has increased a mile and a quarter in length within the century, and the sands which are unceasingly transported to its extremity are now distributed by the ebb currents through the Main Ship Channel over the submerged banks surrounding Gedney's Channel. Under these conditions dredging can furnish but temporary relief, yet it may prove to be the most economical of the several methods available at this particular site. To effect a radical improvement here the encroachments of the beach sand must be arrested. Dikes or jetties in pairs, at this entrance, would be the worst possible expedient.

The commission of the Waterstaat of Holland say: "It is to the action of the tides mainly that the maintenance of the depth in our river mouths must be attributed. The total effect depends upon the *velocity* and *volume;* both increase with the tide-range, that is with the difference between high and low water. If these cannot be increased sufficiently to maintain a profile adequate to the needs of commerce, the end can only be attained by dredging or by a resort to artificial canals."

It is evident, therefore, that any dikes or jetties which would limit or interrupt the tidal oscillation would to that extent prove injurious to the channel, and the greater the tidal range the more serious do such obstructions become, yet the jetty system is the one which is almost universally resorted to as the only panacea for insufficient water over the bars.

Some idea of the magnitude of the works now in progress in this country may be obtained by a review of the expendi-

* See FRANKLIN INSTITUTE JOURNAL for April, 1889.

tures upon a few of our Atlantic and Gulf ports, as given in the accompanying exhibit.

Locality.	Cost to July 1, 1888.		Estimated to Complete.	
Aransas Pass, Tex.,	$481,250 00		$1,668,500	
Pass Cavallo, Tex.,	290,000 00		3,826,457	
Galveston, Tex.,	1,825,278 83		6,752,721	
Sabine Pass, Tex.,	548,750 00	appropriation.	2,051,250	
Mobile, Ala.,	978 830 00	"	276,000	by dredging.
Pensacola, Fla.,	215,000 00	"	25,000	"
St Augustine, Fla.,			1,467,888	
Jacksonville, Fla.,	732,000 00		576,500	
Fernandina, Fla.,	3 6.782 64		1,592,623	
Brunswick, Ga.,	92,463 27		200,000	
Savannah, Ga.,	1,032,000 00		6,660,000	
Charleston, S. C.,	1,482,500 00		1,525,000	
Totals,	$7,984,854 74		$26,521,319	

These works have been in progress for periods of from ten to twenty years, yet none of them are completed. At this rate of making appropriations it will require from thirty to sixty years to complete them, and there can be no question that the cost is greatly augmented by the scour induced by this temporizing method of doling out the funds.

In those cases where only one jetty has been started and that on the wrong side, no beneficial results are manifest. Where two have been built to high water, a slight but temporary improvement is noticeable, during the transition stage, as the crest of the bar is moving seaward and the groins are filling preparatory to the general advance of the foreshore. In these cases the main benefit is due to the protection afforded the ebb channel by that jetty which intercepts the sand movement. In the most prominent cases, as at Galveston and Charleston, there have been no important improvements in depth over the outer bars. At Pensacola and Mobile the improvement is due to dredging and is not permanent.

Thus far attention has been directed to the physical conditions surrounding the problem and space will not permit an expansion into the legislative or executive considerations. These have already been ably presented by experienced and competent economists, and it is therefore not a matter of surprise that at length the subject is

beginning to attract the attention of legislators who desire, in behalf of their constituents, to secure results more expeditiously by securing some changes in the methods of making appropriations and administering these public works.

To this end the Committee on Expenditures in the War Department, Mr. Laffoon, Chairman, in reporting favorably a bill for this purpose, say: "The time has come to inaugurate a definite policy in regard to national public works, and to provide a specific agency for its execution. The sense of the people and of Congress has shown a steady growth for twenty years in favor of the development of harbors and water-ways. During this time grave objections have been urged against legislative and administrative methods, and these objections have gathered force with each passing year. * * * In legislation, it is charged that Congress is not appropriating in harmony with any well-conceived general plan or system; that each work is largely considered as a detached or individual work, without special regard to any other or to any collection or group of works as a whole; that appropriations are uncertain and inadequate for economical results, and often for any results at all; and that the largest and most important national works fail to receive that attention which is indispensable if they are ever to be completed."

"In administration various objections are urged which are largely incidental to the necessary methods of organization of a military body, and that are not adapted to a strictly civil work and function. * * * A necessary, and the larger part of the technical force, is without proper recognition, tenure of position or hope of advancement, resulting in constant change in personnel, as some experience is acquired. The military system does not readily adapt itself to the best civil practice, nor is it desirable that it should if the corps is to remain a part of the army." * * * "The truth of these allegations, to a greater or less degree, is acknowledged by every one. They can be indefinitely multiplied and expanded and have been ably presented to your committee. Great good would come by changing the legislative prac-

tice, likewise by a specific adaptation of the administrative organization to its work."

The importance of such changes as are proposed becomes the more apparent when it is seen that the policy of present methods leads to a reduplication of the unsatisfactory Continental experiences, at great waste of time and expense, while the fundamental requirements of admitting the flood tide freely, defending the ebb channel from the encroachments of the beach sand, conserving the ebb discharge for scour over the bar and providing an ample water-way for navigation are very imperfectly fulfilled by the jetty system as at present applied.

CABLE TELEGRAPHY.

By Patrick Bernard Delany.

[*A lecture delivered before the* Franklin Institute, *Monday, March 11, 1889.*]

The Lecturer was introduced by Prof. Edwin J. Houston, of the Institute, and spoke as follows:

Mr. President, Ladies and Gentlemen:

When the Franklin Institute honored me with an invitation last summer to read a paper on a subject of my own choosing, I accepted on condition that the time be set a good way off, and selected "Cable Telegraphy" as my theme.

We are all apt to be prodigal of promises of remote fulfilment, but as the day of reckoning approaches, we sometimes pay the penalty of our rashness in misgivings of our ability to make our promises good. When I made the engagement I was greatly interested in an invention for cable telegraphy which I was then bringing out, and which I expected would lead to experimentation, and results satisfactory to myself and interesting to the Institute. Realizing as the time for my paper drew near, that my opportunities for experimentation had been very limited, owing

to disappointment in getting facilities for a test of my apparatus, I began to ask myself what I knew about cable telegraphy any way? The result of my mental inventory was such that I determined to change my subject to some other branch of telegraphy, with which I was more familiar, knowing full well that unless I did so I would find myself in the predicament of Artemas Ward, when he appeared before an audience to deliver an advertised lecture on Mormonism. After a survey of those present he said something to this effect: "Ladies and gentlemen, it was my intention to lecture this evening on Mormonism, but as I see a man in the audience who knows much more about the subject than I do, I will have to talk about something else." I am not surprised to find several gentlemen here who know more about cable telegraphy than I do, but I am going to talk to the people and not to the professors. If they find my observations too crude, we will excuse them. I would remind them of Sir William Thomson's admonition that they should be nine-tenths mechanic and one part electrician. When I was showing my synchronous multiplex telegraph system at your electrical exhibition, four years ago, one of the brightest and most practical electricians of our time, Mr. Preece, electrician-in-chief of the English telegraph service, came to me and said: "Now, Delany, I want you to explain your system to me just as though I knew nothing whatever about telegraphy." I took him at his word. In an hour he understood every detail of the system perfectly, and to-day it is working all over England.

I am hopeful that I may be able to present a few facts relating to cable telegraphy in a different light from which they have been heretofore brought before you. I also have one or two other electrical matters to bring to your notice, which will, I hope, to some extent compensate for the barrenness of my presentation of the main subject. I would not have you infer that I have deen disappointed in the performance of my new cable instrument. On the contrary, so far as I have gone with it, it has met my best expectations, and in a short time, when I get an opportunity to try it over the long cables, I confidently hope to make those mysterious

linguistic ligaments talk a little faster than they have ever talked before. Time is very precious with a wire that has an earning power of five or six dollars a minute, and a cable office is one of the places where talk is not cheap. Even at the present rate of twenty-five cents per word, two or three words increase per minute is a very important consideration.

Before entering upon a description of the method of operating cables, I will make brief allusion to the general subject for the benefit of those who have not had occasion to know much about such matters.

It is claimed by our friends over the water that the first cable worth mentioning was laid in 1850, between Dover and Calais, but it is well known that a cable, insulated with gutta-percha, was put down across the Hudson River at New York in 1848. The 1850 cable across the Channel worked but a few hours. Another was laid a year later, and operated successfully. England and Belgium and Ireland and Scotland were soon after connected.

Up to 1857, when Cyrus W. Field projected the Atlantic cable, the longest cable laid was about 600 miles, I think, in the Red Sea. The first attempt to stretch across the Atlantic was abandoned after 350 miles had been paid out from the Irish coast, the cable having parted. In August, 1858, a cable was successfully laid to Newfoundland. It worked but a few days, however. Some contend that the powerful batteries used in its operation burned the conducting wire. There is no doubt about the battery having been too strong, but even so great a man as DeSauty had to learn by experience, costly as it was.

In 1865, another attempt was made, with improved cable, strong enough to sustain eleven miles of its own weight in water. The *Great Eastern* took 2,300 miles of it, in three large tanks, on board. After numerous mishaps, this cable broke when the big ship was 1,000 miles on her way over, and in water nearly three miles deep. During the following year, however, a new cable was laid from Valencia Bay, Ireland, to Heart's Content, Newfoundland, 1,670 nautical miles, and the abandoned cable of the year previous was

picked up, spliced and completed. There are now ten cables across the Atlantic, and their location and condition is about as well known by those who have to do with them as though they were exposed to view for the entire distance. It has been said of Captain Trott, the well-known cable fisherman, that he knows the mountains and valleys, lanes and avenues of the ocean as well as a cabman knows the streets of London. Crossing the Atlantic on one occasion with his repair steamer, and realizing that he was in the vicinity of the spot where a stretch of cable had been lost by another company's steamer some time previous, the captain set to work, picked up the cable within an hour or two, and delivered it to its owners on his arrival. Two of the Atlantic cables were grappled, hauled up and repaired in mid-ocean last summer. It is expensive work, sometimes costing two or three hundred thousand dollars.

There are now throughout the world over 116,000 miles of submarine cables, with nearly 125,000 miles of conductors. Only in short cables can more than one conductor be used. That is to say two wires, each insulated from the other, cannot be operated in long cables on account of a cross-fire known as *induction* between them. Hence, the mileage of cable is almost as great as the mileage of conductors. The Eastern Cable Company alone owns ninety-one cables, extending over 38,000 miles.

I presume you have all seen specimens of submarine cables, and many of you are more or less acquainted with the general method of their construction. It would be outside the object of this paper to describe the various forms. There are several extensive manufactories, each having its own style of construction. The chief objects for which manufacturers have striven have been great conductivity, high insulation, tensile strength, and small bulk. To this end generally the conductor is made of several small copper wires twisted together as one. A single conductor of the same amount of metal, would be too risky, for if it should break, continuity might be lost beyond repair for a long time. Injury to one of the small wires forming the composite conductors would not seriously interfere. The copper

forming the conductor is always of the purest. Then comes the insulation. Unless a cable conductor is well insulated, or protected from the water, the electric current, instead of making itself manifest at the distant end, will leak out into the water and complete a circuit through the earth to the point from whence it came. For it must be remembered, that the conducting wire, although made of the best conducting metal known, offers some opposition to the absolutely free passage of the current. This opposition, termed resistance, corresponds to friction. Now a cable from Ireland to Halifax has a pretty high resistance, amounting in some instances to twelve or fifteen thousand ohms or units of friction, while the entire earth only offers a resistance of a fraction of an ohm, or equal to the resistance of about fifty feet of the ordinary telegraph wire that you see on the poles. Therefore, as electricity is a great economizer of distance and time, never going an inch out of its way, it will go through a fault in the cable in preference to coming over to America. A hole in the protecting shield as big as the point of a pin will let the current out, and if it once gets started, even in a very small way, it will soon make an outlet for itself that will practically put a stop to all telegraphy. This will give you some idea of the necessity for perfection in the manufacture of cables. Of course, the full coating of insulation is not put on all at once. Three or four different coats are applied. Gutta-percha and compounds of a kindred nature are used. Tarred hempen twines are wrapped around the insulation. Then galvanized iron wires are twisted over the hemp, and sometimes they, in turn, are wrapped with fibrous material to protect them from the corrosive action of the water.

All cables are tested before leaving the factory. When put on shipboard, the ship's electrician is in constant communication with the shore through all the cable on the ship. The slightest fault is detected just as soon as it goes into the water. Paying out is immediately stopped, and the cable repaired. You could not see a pinhole in the insulation, but it can be located by the fine testing instruments, sometimes within a quarter of a mile in the entire stretch of 2,000 miles.

The best conductor is the worst insulator. The best insulator the worst conductor. The difference between the conductivity of pure copper and pure gutta-percha, cannot be expressed understandingly in figures. Somebody has calculated that if the difference was reckoned on the basis of the velocity of light, it would take the sunlight a century to reach the earth. Owing to great insulating properties of gutta-percha, but a fraction of current is lost between Europe and America.

People unacquainted with these matters would naturally think, with DeSauty, that so long a cable would require very powerful currents to operate them, but it is not so. There is quite as much battery used in working a wire between Philadelphia and New York as is used on the cable. The reason is mainly on account of the almost perfect insulation of the latter, little or nothing being lost, while in the case of the Philadelphia and New York overhead wire a large percentage of the current goes to earth at the poles. Besides, much coarser instruments are used on the land lines. It would injure the Atlantic cable to apply as much current power to it as it takes to work a land line from New York to Washington on a rainy day. All the current that goes into a well insulated cable at one end, must come out at the other. It would be much better if the insulation of the cable was less perfect. It could be operated much faster. My own opinion is that the great need in cable telegraphy is bad insulation, or a *good bad* insulating material. Something that will not go from bad to worse under the action of the current. Just at this time there is considerable discussion going on as to the necessity for armor wires for deep-sea cables, and also regarding their effect on the working of the cable. It is claimed by many that there is absolute rest at the bottom of the Atlantic, and that tarred hemp covering would be more durable than the armor wires. Many electrical authorities have held that the iron armor wires impede transmission, on account of their influence on the conductor, or magnetic induction.

The greatest living authority in such matters, Sir William Thomson, lays down the law, that while the retarding effects

of magnetic induction may be recognized in cables of about 100 miles in length, it is completely overshadowed in long cables by the greater retardation arising from static capacity. He even goes so far as to accept and indorse Mr. Oliver Heavesides' mathematical proof that magnetic induction increases the speed at which long cables may be operated. While it would be great presumption for me to differ with such eminent authority, I cannot help thinking that there is much of what Professor Tyndale would call "scientific speculation" in these views. I am strongly of the opinion that the unarmored cable would be much faster than the one bound with armor wires. Aside from electrical considerations, it is believed that armor wires are necessary to protect the cable from chafing on the rocks, and from the teeth of the parasite, which fares sumptuously on hemp, tar, gutta-percha, and other apparently indigestible substances. Everything is said to have its parasite, and it is proven that cables at the bottom of the ocean have not been overlooked. Cables have been taken up from a depth of a mile and a-half, with the hemp covering badly eaten away, and at a depth of over half a mile strong currents of the ocean have rasped the armor wires on the rocky bottom. To overcome this latter difficulty the shore ends of cables are always made much heavier and stronger than the deep water cables. Experience has not yet determined the full lasting qualities of electric cables. Specimens have been taken up which show no signs of deterioration after having been in the water for more than thirty-five years. Water, and especially salt water, seems to be a preserver of insulating compounds.

The method of operating cables has been so fully and learnedly explained in many books on electricity, that it may seem a waste of time to go over the ground in a less instructive way, but I do not intend to attempt more than a description, in simple language, of the elementary principles of operation, hoping thereby to be able to make clear to your minds the nature of my own endeavor in the direction of improvement, and in what respect it differs from the present plan. Almost everybody in these days has some knowledge

of how land lines are operated. They have become accustomed to seeing the operator manipulating his key, and although the click of the sounder has no meaning to their ear, still all know that the working of the key at one end of the line causes the sounder to work at the other end. Although not a country in Europe, except England, uses the sounder, the clicks, recorded in dots and dashes on the strip, have the same meaning. It is the only real Volapük language. The marks on the paper might be likened to the music score, while the sounder is the tune itself. We are admonished that we should believe nothing that we hear and but half that we see, but experience has proven that in

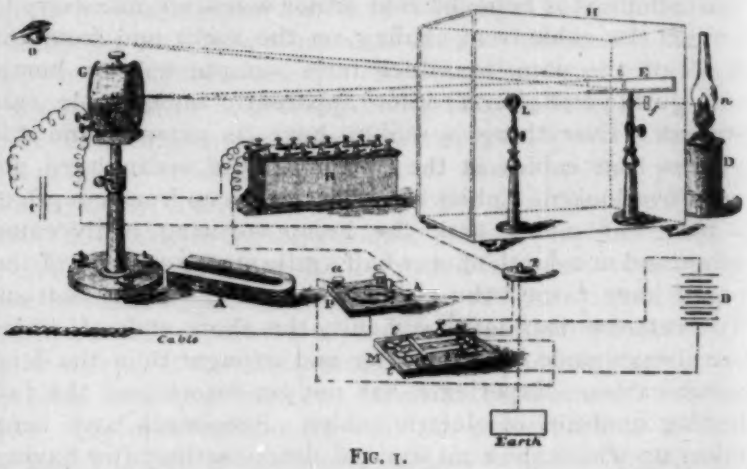


FIG. 1.

telegraphy the ear is more correct than the eye. Furthermore, telegraphy can be carried on much more rapidly by sound than by reading from the paper strip. We should be proud of the expertness of our American telegraph operators, for I doubt if there be on the entire continent of Europe an operator that could copy thirty words per minute by sound for five consecutive minutes. Our operators have to do this, or very near it, all day long.

It is not the fault of the foreign telegraphists that they are not sound-readers. They are, in the main, well educated, bright and intelligent, but the administrations have no confidence in this way of working, and refuse to trust it.

It was forbidden in this country up to about twenty-five years ago, but Young America couldn't plod where he could just as well progress, so the telegraph managers soon found that they were simply wasting paper. The operators read by sound.

On long cables, such as those across the Atlantic, the Morse relay and sounder are too coarse for the exceedingly delicate impulses that come through the cable. It might be possible to work a very sensitive Morse relay, but at an impractically slow speed of perhaps two or three words per minute. The cable would be clogged up by the strong currents required. The weaker the current the faster the speed; hence, everything depends on the sensitiveness and delicacy of the receiving instrument. The most sensitive of these is the Thomson reflecting galvanometer. (*Fig. 1.*) It consists of a small piece of steel, no thicker than a watch-spring and about three-eighths of an inch in length, suspended by the finest silk fibre in the centre of a coil of fine insulated copper wire. To this small steel compass is fastened a looking-glass, about as large as the blunt end of your lead pencil. Opposite this needle and its reflector, and perhaps three or four feet away, is a lighted lamp and a screen. In the centre of the screen is a neutral or zero point, where the beam of light reflected by the small looking-glass rests when there are no signals coming. A permanent magnet is placed in such magnetic relation to the small piece of steel as to cause the beam of light to return to the neutral point quickly after having been carried to the right or left by an impulse of current coming over the cable. Instead of using a single key and making dots and dashes with a current of one polarity, merely tapping the key for a dot, and holding it down for a longer time for a dash, as in ordinary Morse telegraphy, the present cable system requires *two* keys, one connected to a positive, the other to a negative battery. Now, assuming that a tap on the positive key will swing the beam of light to the right in Canada, that signal would be recognized as a dot. Then, if the other key connected to the negative battery be tapped, the beam of light will swing to the left of the zero line and will denote a dash. You will

observe that no dashes or long contact with the battery are admissible in this system, and the aim of the operator must be to make the taps on each key of the same duration, so that the reading light will return to its neutral position quickly and uniformly after each signal. This is the fastest system of ocean telegraphy in use.

The receiving apparatus is placed in a darkened room. The receiving operator calls off the letters one by one to a copyist who writes them down. It is tiresome work for the receiver, whose eyes must never leave the moving ray silently speaking to him from the other shore. To verify a letter of doubtful sound, a familiar word beginning with the letter is quickly pronounced. For example, after calling out

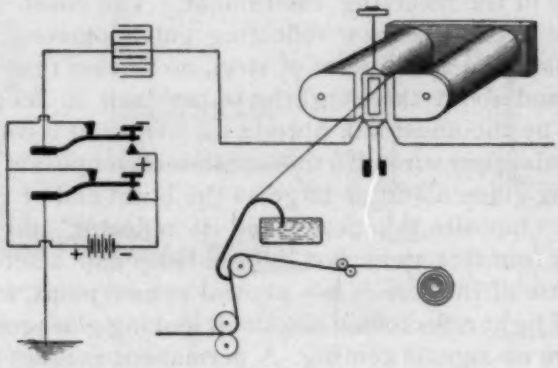


FIG. 2.

the letter D, the receiver might say "dog," so that the copyist could not mistake D for B, C, G or E. The average speed of transmission by this system is about fifteen words per minute for regular messages. A later and preferred system of cable signalling now in very general use is the Thomson Recorder System. The signals are recorded in ink on a paper strip. Although not quite as fast as the mirror system, and a little less sensitive, the recorder is recognized as a marvel of ingenuity and perfection, considering the work it performs under such difficult conditions. This rough diagram on the screen (*Fig. 2*) will show the arrangement of the transmitting keys and connections. Everything is the same as already described in connection with the mirror system,

but I wish to make it perfectly clear to you by the diagram, as it is between this system of transmission and my own system, which I am coming to soon, that I wish to draw a few comparisons. This diagram also gives an outline of the Thomson Recorder. In a few minutes I will show you on the screen a recorder complete. Referring now to the diagram before us, you will have no difficulty in following the circuit connections. We must assume that the recorder is at the distant end of the cable, and the keys, batteries

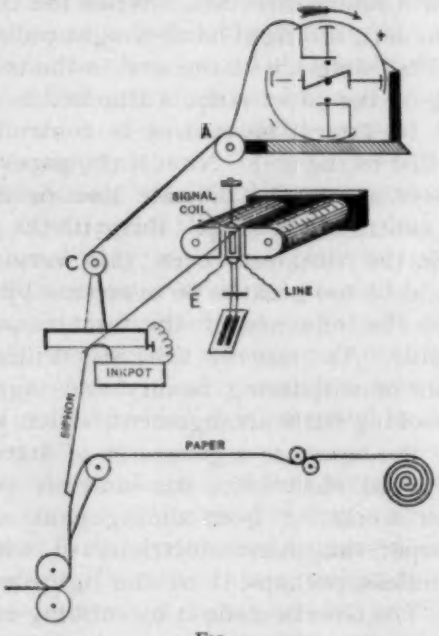


FIG. 3.

and condensers are at the transmitting end. In their present position, both transmitting keys are disconnected from the battery, and the cable is connected to earth. As but one key is pressed down at a time, the cable is connected to earth between each impulse. Now with the complete drawing of the recorder before us (*Fig. 3*), we can understand how the signals are received on the paper strip.

Instead of a small piece of steel suspended in the centre of a coil of wire, as in the case of the mirror instrument,

we have here a small coil of wire suspended between the poles of a powerful permanent magnet. The wire in this small coil is so fine that several pieces of it might be put in the eye of a cambric needle at the same time. It is suspended by a very slender silk thread. To the bottom of the coil two weights are attached, which bring the coil into proper relation with the lines of force of the permanent magnet, so that when an impulse is received from the distant end it brings about the greatest amount of swerve of the coil in a rotary direction. When the current swings the coil to the left, the right-hand weight pulls it back, and *vice-versa*. The siphon with one end in the ink-pot and the other resting on the paper strip, is attached to an adjustable support, and its lateral movement is controlled by a silk thread attached to the coil. Now, if the paper be pulled by the feed rollers, a straight delicate line in ink would be made in the centre of the strip. But with the siphon touching the paper, the friction of even this very delicate contrivance would be too great to be overcome by the swing of the coil under the influence of the faint impulses coming over the cable. To remedy this, Sir William Thomson devised a plan of surpassing beauty and ingenuity. This mysterious looking little arrangement, which you see here at the top of the figure, is a generator of static electricity.

It is frictional electricity, the same as you get from belts in your works, or from sliding your slippered feet across the carpet, the oldest electricity of which we have any record, unless, perhaps, it be the lightning that Ajax challenged. The Greeks made it by rubbing amber. Well, this is what Sir Wm. Thomson uses to relieve this little siphon of friction in its oscillations. The static generator is run by a small electric motor, generally known as a "mouse mill." The electricity ground out by this little mill is conducted by a damp string or wire to the ink in the ink-pot, which is well insulated from the base. It then finds its way through the ink in the small glass siphon to the paper, where it is discharged. The siphon, which is as fine as a hair, is normally adjusted so as to just escape the paper. The static electricity attracts the siphon to the paper, but

as soon as the ink touches the paper the current is discharged, causing the siphon to rebound. Thus, the siphon may not really touch the paper, but the ink is deposited in dots so close together as to form a practically continous line. The discharge and consequent vibration of the siphon will number, perhaps, fifty per second. In this way the small coil of wire meets with little or no hindrance in its movement and a permanent record is made on the strip which, if obscure or doubtful, may be scrutinized with deliberation. Not so with the mirror receiver. If a letter or word is not translated while the beam of light is swinging it is lost and must be repeated. This beautiful electro-static device for overcoming friction has but one drawback. It is quite difficult to confine the static current to its proper channels in damp weather. Its high potential makes it difficult of insulation. Mr. Cutriss, mechanician and electrician of the Commercial Cable Company, has devised and put in operation a very ingenious plan for obviating this difficulty and it does it most successfully. Instead of a static generator such as described, he fastens to the end of the siphon where it touches the paper a piece of iron about the size of a pin's head. Underneath the paper is an electro-magnet, the circuit of which is interrupted by an adjustable automatic vibrator.

In this way the small speck of iron attached to the siphon is attracted each time the circuit of the magnet under the paper is closed, and a vibration imparted to the siphon corresponding with the rate of the automatic circuit breaker, or, to be more correct, the circuit breaker is adjusted to the natural rate of vibration of the siphon.

Now, having considered the method of operation,we may analyze briefly the theory involved.

I will submit a few general proportions upon which to predicate a few deductions later.

The reason why relays and sounders are not used for cable work is that they require comparatively strong currents to affect them. Strong currents cannot be used, because they are injurious to the cable and prevent rapid signalling. The question arises then is it possible to make

a relay that will work with the present current pressure and make and break the local circuit of a sounder, so that signals may be received by sound at as high a rate of speed as at present obtainable by the mirror or recorder instrument?

It is a most hazardous thing in these days to say that anything cannot be done. I have no hesitation in saying that at no very distant day the Atlantic cables will be operated by relays and sounders, but not with the present system of transmission of the impulses. And I am also strongly of the opinion that the present mirror and recorder systems may also be operated at a considerably higher speed by a change in the method of transmission. Or, in other words, I maintain that the system of transmission which will make relays and sounders of the future work practicably on long cables is now available for the improvement of the speed of the present receivers. I alluded some ways back in this paper, to obstacles in the way of operating cables with the same facility that land lines are worked. I now return to that part of our subject, and if you will continue your patient attention for a short time longer, I hope to be able to make the cause and effects touched upon clear to you all. You all know the Leyden jar. That it comprises a glass jar with a coating of foil inside and another outside, each completely separated and insulated from the other by the glass. You also are well aware of the fact that if one of the coatings of metal be charged with positive electricity, the other coating will be inductively charged with electricity of an opposite polarity. It is the same with a condenser made up of sheets of tin-foil and separated from each other by sheets of paraffine or any high insulation.

A submarine or subterranean cable is nothing more than a Leyden jar or condenser. The conductor is one plate, the insulation is the glass jar, and the armor wires and water the other plate. Consequently, when a current impulse is sent into the cable, an opposing current makes its appearance on the outside and in the insulation. This unwelcome outsider weakens the real impulse in its passage through the conductor, and, worse still, takes possession of the conductor

itself when the first current ceases, and opposes the entrance of the next current impulse.

Thus it is, that, after each signal is sent into the cable, we have what is known as static discharge. It is only static, or in a state of rest, so long as the signal current is in possession of the cable, for when the cable conductor is put to earth, as is done after each impulse, as shown in the drawing, it runs out, most of it towards the end at which the signalling current went in, but some of it goes towards the distant end, prolonging the signal at that end much beyond its length at starting. Now, for the reasons already explained, currents, whether real or vagrant, travel slowly in the cable. It requires about one-tenth of a second for an impulse to cross the Atlantic.

If the cable conductor was on poles fifty feet above the surface of the water, the impulse would make a dozen round trips in the same time. Now then, after sending in one impulse, the operator cannot wait for the static discharge to run out completely. This would render transmission unprofitably slow. Another impulse must follow, but, owing to the blocking up of the way by the static current, it arrives delayed and depleted at the other end. In cable telegraphy, as at present conducted, I have shown that two keys are used—one for sending positive currents, the other negative, and representing dots and dashes respectively. Now then, if the letter A is to be sent, the positive key is first tapped and the siphon is carried towards the top of the strip. Then the negative key is tapped and the siphon is carried towards the bottom of the strip. These two movements up and down will represent A, and there is no mistaking it. This letter was formed of alternations of the current—positive and negative. It will be different with letter B. It requires four signals—a dash and three dots. The negative key is pressed down once, and immediately afterwards the positive key is pressed down three times in succession. Thus one negative current and three positive currents were sent. The effect of the negative impulse was to carry the siphon below the horizontal line representing the dash. The first of the three positive currents brought it back to a

position slightly above the horizontal line. The second carried it a little further in the same direction, and the third still a little further. I have on the screen several specimens of cable records (*Fig. 4*). Although the variety is not great they are sufficient to show the effects of static capacity and retardation.

This 4–4 strip shows an alphabet in the Continental code, received over the Direct United States Cable Company's cable at Halifax, from, Ireland about three weeks ago. It is not a first-rate specimen, owing to the fact that the cable is generally worked with the mirror system, and the recorder was set up temporarily by the obliging management just to get me this record. It is a fair sample of every-day cable-work, however. This and the other strips on the diagrams which you have are one-third below the actual size, having been photographed down. You will see that the three dots of the letter B resemble three steps of a stair, but without the sharp outline, and you will observe that the last dot is less distinct than the second, and that the second is not as plain as the first. The dots in letter H answer the description even better than B. The explanation of this is that the first dot represents the scope of the swing of the suspended coil of wire under the influence of a reversal of the current from negative to positive. The second dot simply shows a slight fall in the potential of the cable, owing to the breaking of the current at the sending end, and the third shows a still smaller undulation. The cause of this is that, after the first dot was made and the battery withdrawn at the sending end, the static current continued to run out at the receiving end, still holding the siphon above the horizontal line, to which point it would otherwise have returned quickly, and in its exit at the transmitting end weakens the next dot coming in. The third dot shows that the cable was still more clogged up than when the second dot came through, and so on. If dots were sent continuously, there would be nothing but a straight line, provided the dots followed each other in reasonably rapid succession. It must not be inferred that additional dots would keep on carrying the siphon higher and higher, for

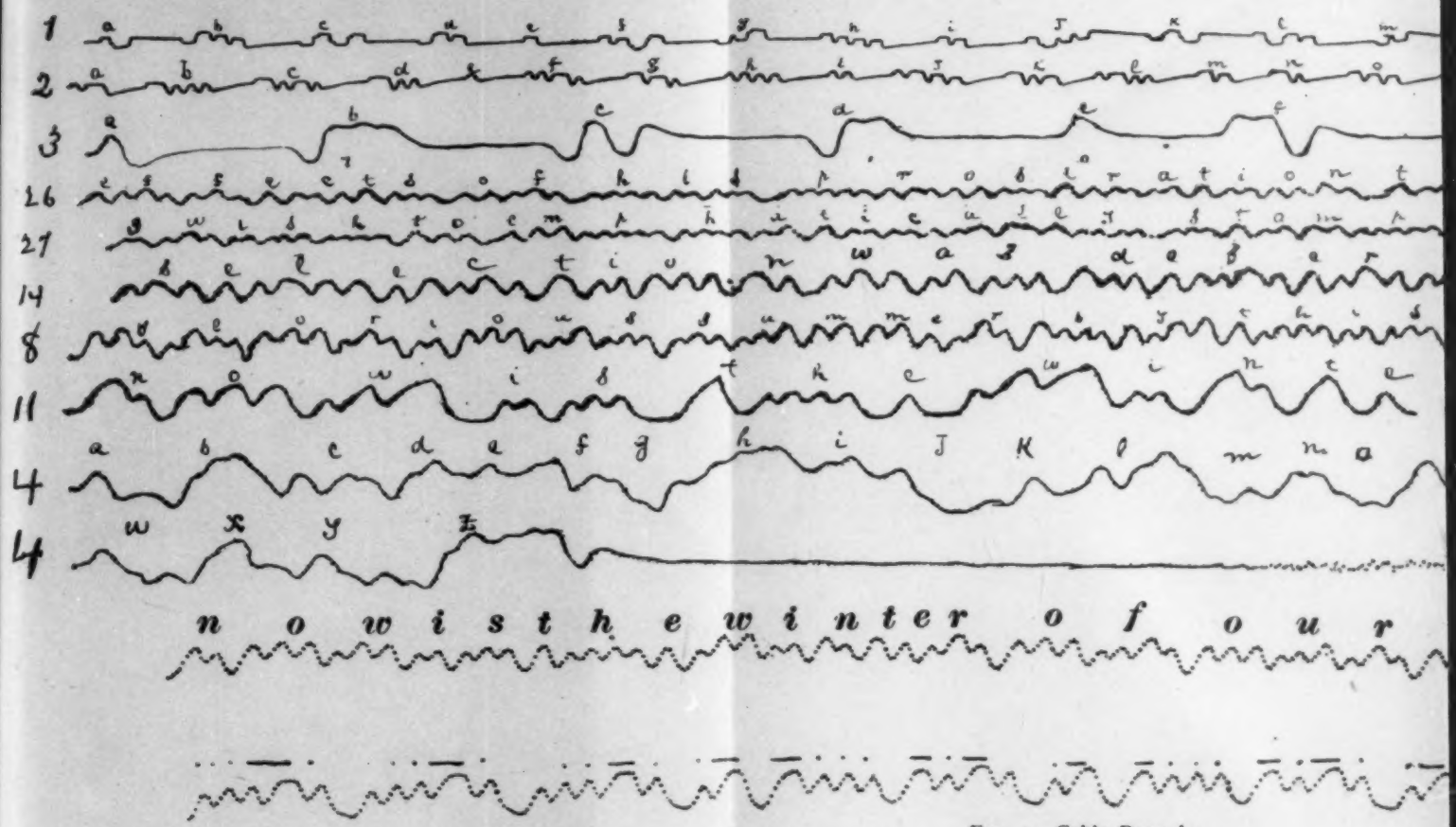


FIG. 4.—Cable Records.

THE DELANY LINE ADJUSTING SYSTEM

FIG. 6.

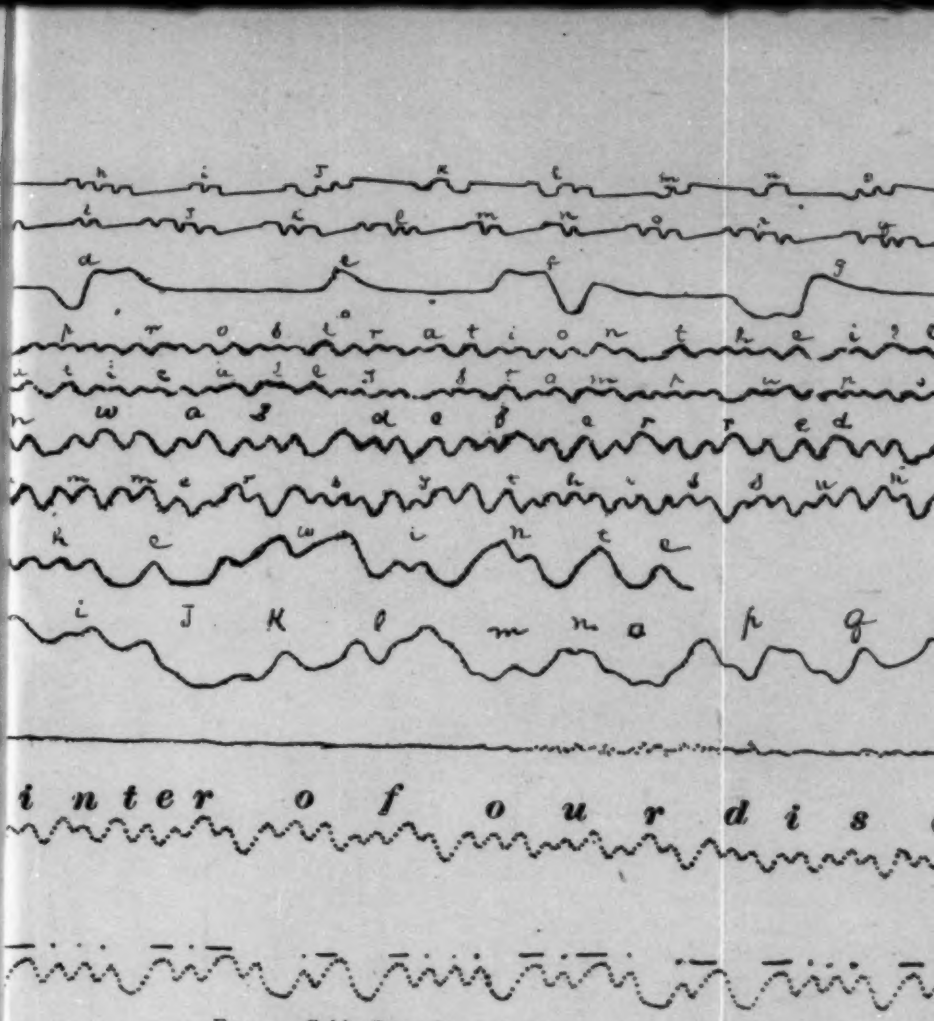
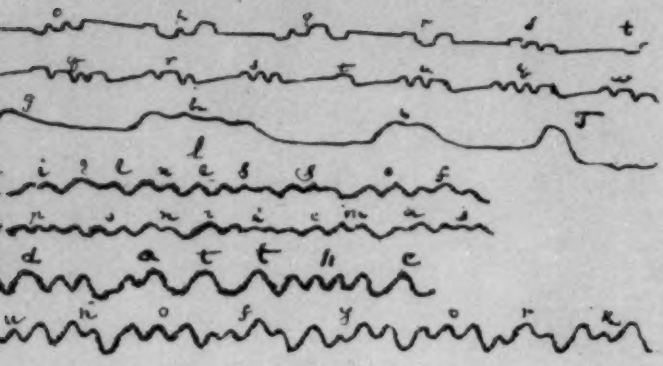
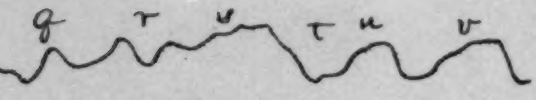


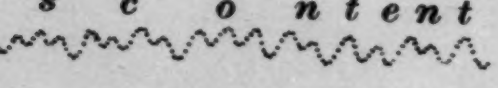
FIG. 4.—Cable Records.

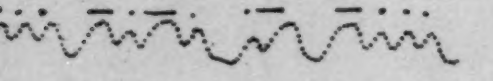
HE DELANY LINE ADJUSTING SYSTEM

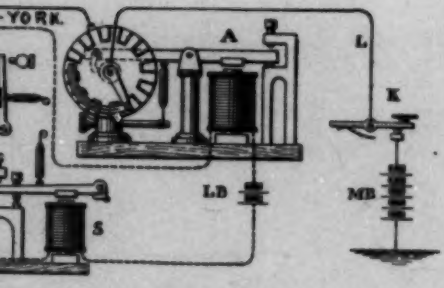
FIG. 6.







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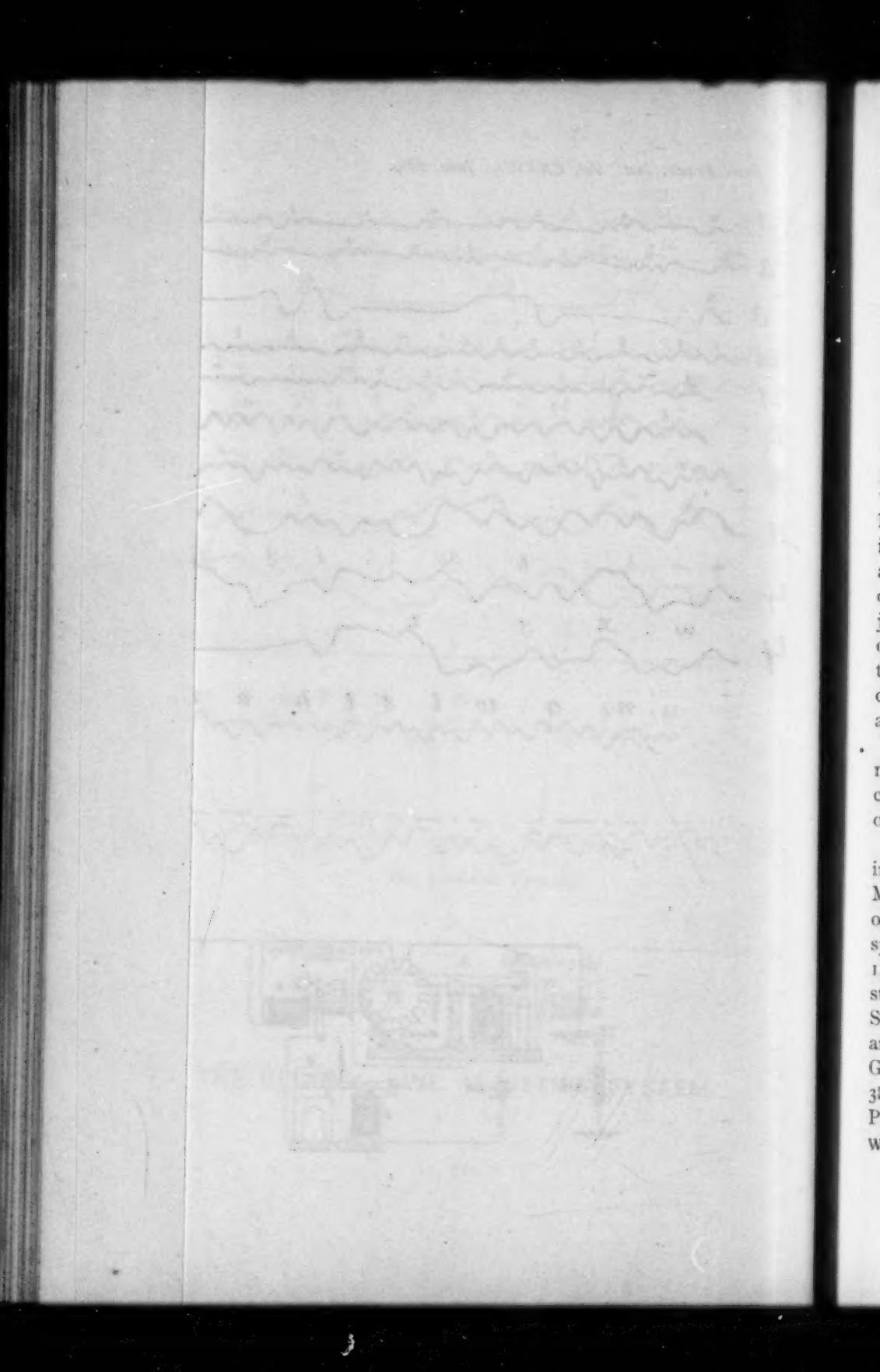

such would not be the case. The maximum influence of the current for turning the coil around is reached in three or four impulses, and if the current was permanently connected the siphon would make a straight line above or below the centre of the strip, according to the polarity of the current coming over the cable.

You will readily appreciate the degree of proficiency and experience necessary on the part of the cable operator to translate correctly these wavy lines and almost imperceptible undulations, especially when we remember that nearly all cable messages are in cipher, without meaning or context to aid the operator. The high charges have been productive of codes so constructed that a single word may, when translated, be as long as the Lord's Prayer. Ten letters are allowed to a word. If it goes one letter over it is charged for as two words. The addition or omission of a letter in a word may change the entire meaning of the cablegram. The cable operator must exercise wonderful judgment. When the dots or dashes are practically devoid of any characteristic but a straight line, he determines their number by the length of the line occupied by the doubtful letter. The strain on the mind is great, for fines are imposed for errors.

To facilitate business, and as a further safeguard against mistakes, in some offices two operators examine the strip as it comes from the instrument. The second operator verifies or corrects words indicated as doubtful by the first.

The most interesting and really wonderful telegraphing in the world is carried on by the Eastern Cable Company. Messages are sent from Bombay to Penzance, over a series of cables which, by what is known as the "Human Relay" system, is practically continuous. Bombay sends to Aden, 1,832 miles. An operator at Aden reads directly from the strip, and at the same time transmits to Suez, 1,403 miles. Suez in like manner sends to Alexandria, 154 miles. Alexandria operator sends to Malta, 925 miles. Malta repeats to Gibraltar, 1,125 miles. Gibraltar in turn sends to Lisbon, 383 miles, and finally the operator at Lisbon sends to Penzance, 891 miles. A total distance of 6,713 miles with-

out a word being written. This weird message of mankind enters ocean after ocean and sea after sea, bobbing up serenely at intervals, as though to get breath for a fresh dive. As nearly all cable circuits are worked upon the duplex plan in these times, this matchless transmission is not interrupted for corrections or missing words. The message is kept moving to the end, and if found wanting in any respect inquiry is sent back to Bombay on the other circuit. So that the routine goes on like an endless chain.

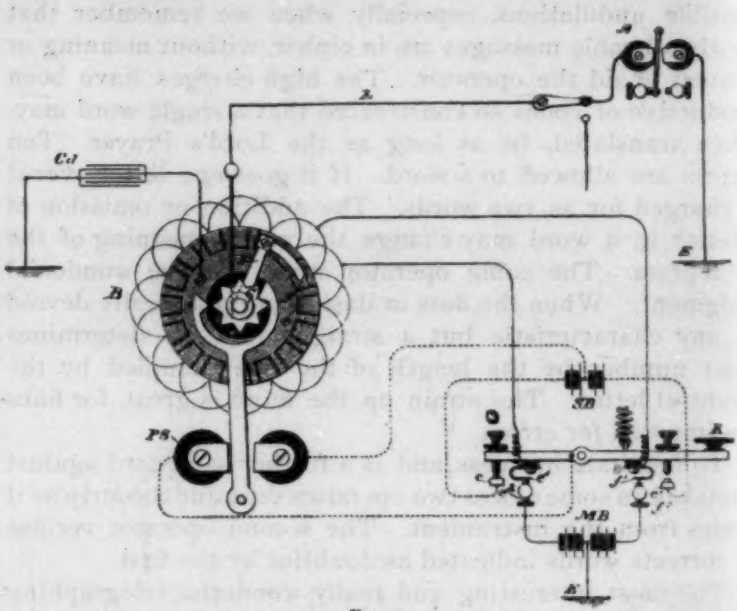

FIG. 5.

I do not think it necessary to take up any further time with the theory and practice of the present system, but will come at once to an explanation of my own system of transmission, which I will endeavor to make as short as possible. I must ask you to give me your attention while I have recourse to this excellent diagramatic view of the apparatus, (*Fig. 5*), and if you will bear in mind what has already been said upon the theoretical operation of cables, it will take you but a few minutes to recognize the difference between the systems explained to you, and the one I am about to

describe. The main features of this system are, that successive impulses of the same polarity are never sent into the cable. That each signal impulse is followed by another, which opposes and neutralizes the static charge in the cable, and clears the way for the next signal impulse. Also that all the signalling impulses are of practically the same duration, and that the clearing impulses are absolutely of the same duration. And, finally, that transmission is done by the use of an ordinary Morse key, so that any operator can send messages. The two-keyed system requires even more practice to become proficient than single key working.

I have explained to you how a series of impulses of like polarity may appear as a straight line on the strip at the receiving end, according to the frequency with which they follow each other. So also may regular reversals become almost a straight line if they are sent in sufficiently rapid succession, and they might be sent so quickly that no current at all would reach the receiving end, the discharge from one completely obliterating the next. They would strangle each other in the cable. I am convinced, however, that if each signalling current is immediately followed by a neutralizing current of electro-motive force, adjusted to the static discharge, the speed of signalling may not only be greatly increased, but the received marks will be unmistakable. In support of my claim, that by keeping the cable in a state of stable equilibrium by the neutralizing impulses, I would state that early last summer I transmitted 680 perfect impulses over a cable of nearly 1,000 miles in length, having a resistance of 13,000 ohms, and an electro-static capacity of 240 microfarads, and this with eight volts—just one-half of the electro-motive force used on this cable ordinarily. This is equal to more than thirty words per minute and the record was as even as if it had been engraved. In September last, I made two experiments over the Anglo-American cable between Duxbury, Mass., and St. Pierre, Island of Miquelon. This cable is 878 miles in length, has a resistance of 8,300 ohms and a capacity of 256 microfarads. The result of these experiments, hurried and unprepared as they were, I have endeavored to bring to your attention on

a small scale by having the records reproduced in *fac-simile*. You will find them on the sheet.

Owing to the faint lines made by the recorder, and to the fact of the ink being blue, it was necessary before photographing to go over the strip with pen and ink, which has, to a considerable degree, robbed them of their smooth outline, so that they do not appear to as good advantage. If you will look at the sheet, I will give the record of each specimen beginning at the top. Number 1 is a portion of the continental alphabet, not sent over the cable, but made locally at Duxbury by the present system of transmission, and by throwing the duplex a little out of balance. It may be considered an ideal specimen. The dots are above, the dashes below the horizontal line, represented by the long straight lines between each letter.

The dots you will remember are all made by one polarity of current, the dashes by the other. No signs of the clogging effect of static capacity are visible in this strip, because the signals were not sent through the cable. Number 2 is by my system of transmission, made under the same conditions. My transmitter puts both dots and dashes at the top, or above the horizontal line. Telegraphers must bear in mind that this is the Continental code, several letters of which differ in construction from our American Morse. I consider the foreign alphabet better than ours. There are no space letters, consequently less liability to error. Our code is faster, however. The Continental C, is an American J; our Q is their F. Their R is our F; an American X is a Continental L, and so on. It is somewhat puzzling for a sound-reading operator, knowing both alphabets, to read first one and then the other by sound without confusion. I have had some experience with this sort of thing myself. On one occasion I asked an English operator over the wire how my system was working, when he answered back "axx fight," I was content. Now telegraphists will recognize a dot and a dash for A. Dash and three dots for B, and dash dot, dash dot for C, dash and two dots for D, one dot for E, etc. Specimen number 3 was received over the Anglo-American Cable at Duxbury from St. Pierre. By the long waits between the

letters you will see that it was sent at a very slow speed, perhaps eight or nine words per minute. Here we have the effects of choking up of the cable by succeeding impulses of like polarity beautifully illustrated. Observe letter B—a dash and three dots. The lower loop is the dash, the undulations at the top the three dots. Compare these with the letter B in specimens 1 and 2, which were made on a local circuit. The dots in D, F, H and I show the same difference, also the dashes where they succeed each other as in G—two dashes and a dot. Now you will see that if the cable had not the capacity for storing electricity the record three would be like 1 and 2, plain and rapid.

You may say you do not see in specimen 3 the step-by-step feature referred to awhile ago as resulting from successive dots of like polarity. It is because the cable is not a very long one—less than 900 miles—and the speed at which this record was made was so slow as to allow the siphon to drop down between each dot.

I will call your attention to this effect again in specimen 4, sent across the Atlantic. This is the alphabet complete. B, D, H and I show what sort of a passage the poor struggling dot has to contend with coming under the Atlantic. If you will examine this closely, you will see the original line of dots in some places where the tracing pen went slightly to one side. The straight line at the end is the horizontal or neutral line made by the recorder when there was no current in the cable. The break-up in the middle, which looks like the splutter from a pen, was probably caused by a jolt of the table or a jarring of the floor. All the other specimens are some of my own transmission from Duxbury to St. Pierre. These specimens are odds and ends, picked up after the best specimens had been distributed. I have a number of specimens pasted in my book collection here, which are infinitely better than those shown you. Had it been possible to photograph them without inking them over, I would have done so. In fact, none of the specimens shown you represent the best adaptation of my system of transmission, but I will be glad to show those interested cable strips, that any telegraph operator can read, sent at twenty to thirty words per minute.

Specimen number 11 was at the rate of thirteen and one-half words per minute. You will notice a great difference between the dots in the specimen and those in specimen 3, sent by the present system from St. Pierre to Duxbury, and at a speed of not over ten words per minute. You can judge of the relative difference in speeds by the condensation or elongation of the characters on the strip. The paper runs through the instrument at an even speed always.

Specimen number 8 was at the rate of eighteen and four-fifths words per minute. The first letter is G, the next L. The photograph process has made the printed letters indistinct.

Specimen 26 was at the rate of twenty-six words per minute. This specimen, as well as 27, are according to the American code. The pen-tracing has injured them badly. They have been reduced one-third by the photograph.

Owing to a misunderstanding, I had but one-half the battery that I was entitled to when these specimens were made. All these things combined is the cause of the small undulations, although the specimens I have in my book are very plain, even number 27, which was transmitted by a Western Union operator who could not send a word by the two-key or cable system. The speed of this 27 specimen was a fraction over thirty-four words per minute. You will see that, even in this specimen, the dots are quite as distinct at thirty-four words per minute as they are in specimen 3, at ten words per minute, and 3 had double the electro-motive force behind it that was given to 27.

The last two specimens, those without numbers, are perfect *fac-similes* of my best work between Duxbury and St. Pierre. Every dot is carefully reproduced. The first of the two, "Now is the winter," etc., was transmitted at the rate of twenty-two and one-fifth words per minute, five letters to a word. The other, at the rate of twenty words per minute. The transmission in both cases was made *direct* to the cable, not through condenser, and with 100 microfarads condenser connected to the intermediate segments for the purpose of neutralizing the static discharge in the cable.

I was compelled to take the condenser out of the cable for this purpose, it being the only one available. These, as these two records plainly show, were by far the best conditions for working, and this is the arrangement with which I hope to work the Atlantic cables by sound, at no very distant day.

A study of these specimens will, I think, show conclusively the difference between merely breaking the circuit, depending on the drop in the potential of the cable for the signal, and reversing the current each time that a signal is sent, thus drawing the siphon to the other side of the horizontal line.

I wish to call your particular attention to one result obtained between Duxbury and St. Pierre with my system of transmission, of which I have no wavy tracing to show you. It was not that kind of a result. I sent twenty words per minute for five consecutive minutes, and every dot and dash were received perfectly in St. Pierre *by sound.* At twenty-four words per minute, St. Pierre reported the work a trifle shaky, but the gentleman receiving reported that he had had but little experience in adjusting the Brown and Allen relay, which was connected on for the occasion. I am confident that this circuit can be worked perfectly by sound at thirty words per minute. Repeated efforts during the past twelve years have failed to get more than three or four words per minute over this cable by sound.

If you will now take up the diagram of the transmitter and connections which you have, you will find no difficulty in following me while I explain the method and theory of the instrument. (See *Fig.* 5.)

A represents a receiver at the distant station. An ordinary polarized relay is shown, but it might be a mirror instrument or a Thomson recorder, both of which have been described, or any other receiver. One side of the relay is connected to earth. To the other side is connected the line *L*, or cable. This line is connected to the revolving trailer *T* of the polarized transmitter *PS*. The trailer is carried by the spindle of star-wheel *C*, revolved by the pallet end of the armature of *PS*. *Cd* is a condenser connected to the plate

which projects between the segments in the circle. There are two sets of segments e and f in the circle besides the plate segments. Set f is connected to insulated contact f' under the front of the key. Segments e are connected to the insulated contact e' at the other end of the key. Contacts f^2 and e^2 are connected respectively to the positive and negative poles of a main transmitting battery MB, which is grounded in the middle. The key is connected to the polarized transmitter PS, thence to the middle of local battery SB, the ends of which are connected to the contacts c and c' under the back and front ends of the key. As everything now stands, the cable is entirely disconnected. The operation is as follows: If the key K be pressed down the positive pole of battery MB is connected to the cable through contacts f^2 and f' and segment f, upon which the trailer is resting. When the key reaches contact c', which is its limiting stop, the local circuit of magnet PS is closed and the armature thrown to the right, which moves the trailer off of segment f and breaks the connection between the cable and the main battery. Now, then, if you will look closely, you will see that the trailing finger is slanting, so that it bridges segment f and the intermediate or plate segment connected to the condenser while it is passing from segment f to the next segment, above which is one of the e set, and in doing so connects the positive pole of the main battery MB to the condenser, thereby charging it. When the trailer leaves segment f and touches only the condenser segment, the charge which the condenser received, while the trailer bridged the two segments is sent into the cable and meets and neutralizes the static discharge created by the impulse which went into the cable when the key was closed and the trailer was on segment f. The trailer does not stop on the condenser segment, but passes over in one movement of the armature of PS to the next segment group, which is connected to the contact e' at the back of the key.

Now, if the key be raised the negative pole of the main battery MB is connected to the cable through contacts e^2 e', segment e and the trailer. Immediately that the key reaches its limit, contact c, the local battery SB is reversed through

PS, and the armature moved to the left again, which terminates the contact of the negative pole of the battery with the cable, charges the condenser and discharges it into the cable as before, thus neutralizing the static discharge coming out of the cable from the negative impulse sent in. In this way, signalling impulses of alternative polarity are sent into the cable and discharge impulses from the condenser neutralizes the static charge in the cable. The force of the condenser discharge may be adjusted to the capacity of the cable by the use of resistance in the condenser circuit. You will observe that the duration of the contact of the cable with the main battery is determined by the time f', f^2 or e' e^2 come together in advance of the local contacts c',c^2, which reverse the circuit of the transmitter *PS*, plus the time required for the trailer to pass off of the segment. This time may be lengthened or shortened, within limits, by adjusting the key contacts. I have, however, a plan for lengthening the duration of contacts, which affords a much wider range, and by which the impulses may be adapted to any length of cable.

THE DELANY LINE ADJUSTER.

I have kept you so long already, I hesitate to claim your attention further. But I have something here which comes nearer home to all of us than cable telegraphy, and which is of the first importance in land telegraphy, more especially on railways. Indeed, I think it promises to become as useful to the telegraph line as the air-brake is to the train. It requires but little explanation, as I have the system set up, so that it can speak for itself. The apparatus is known as the LINE ADJUSTER. This is a comprehensive title to telegraphers. Relay adjuster would be more correct, but as it keeps all the instruments on the line in adjustment, I have given it the broader name of "Line Adjuster."

I presume that nearly everybody knows that land telegraphs work much better in dry weather than in wet. Every one here must be electrician enough to appreciate this one fact, after all they have heard this evening about the

current running down the poles. A little loss, as I have told you, is a good thing, but a rainy day is too much of a good thing for the telegraphs, as it robs the wires of too much current. In such weather the instruments need careful adjustment. At way stations the operators are not usually as proficient in this regard as they might be. Their instruments being out of adjustment, they do not hear other stations calling them, and if they have a message to send, they "break in" on the work going on over the line, calling away and not hearing the answer. How often have we been forced to listen for an hour at a time to uninteresting conversations going on between two oblivious youngsters, while life and death messages hung on the hooks, waiting for them to finish or adjust their instruments? I will not ask how often we have been there ourselves, for we have the floor, but all must admit that interference and failure from causes of this kind are the loudest crying evils of telegraphy. This adjusting system will do away with the difficulty thoroughly, for, so long as the terminal stations are adjusted, all the intermediate instruments *must* respond. Here we have an excellent diagram of a line between Philadelphia and New York, with Trenton and New Brunswick shown as way stations. There are, I suppose, forty telegraph stations between Philadelphia and New York. So many instruments in a line make it work badly. Now, if a rain-storm comes up, the current from the main batteries at Philadelphia and New York runs down the poles to ground. If the rain made a perfect earth connection, instead of a partial one, of course Philadelphia could work with no one beyond the point at which the line was wholly grounded. If we should run a wire from line to earth between Trenton and New Brunswick, Philadelphia and Trenton could communicate with each other, but could not reach New Brunswick or New York. In the same way, in bad weather, a station near Philadelphia—Frankford, for instance—will have no difficulty in working with Philadelphia, but, owing to the partial ground connection beyond him, he cannot get Trenton, New Brunswick or any other station so well. It might be that, although adjusted for Philadelphia, his instrument would

remain silent when New York was working. If he adjusted his instrument properly, so as to get New York, he could also work with Philadelphia on the same adjustment, but operators do not always exercise this discretion.

Now it is just here where this adjuster comes in and insures against the carelessness or inefficiency of the operator. After going over the diagram on the paper, I will create an artificial rain-storm between Trenton and New Brunswick, and prove to you that this little instrument keeps things straight all along the line. Please look at the diagram, *Fig. 6*. The instrument *A* is the adjuster. It is the only addition to the usual outfit. The key *K*, at Philadelphia, is down, or closed. The main battery goes to the segment plate upon which the trailer is resting, through the trailer to the relay, and thence on through the instrument at Trenton and New Brunswick to the New York relay, to the segment of his adjuster, through the trailer to the key *K* and main battery to earth. Here we have a closed circuit. Now ordinarily when Philadelphia wishes to send to New Brunswick, or any other station, he begins by opening his key, thus disconnecting his battery from the line. This causes all the relays and sounders on the line to respond if they are adjusted, but if it be a bad day, and there be considerable connection to ground down the poles, New York's battery being still connected to the line, finds its way to the ground all the way to Philadelphia and makes a circuit for the instruments at New Brunswick and other stations along the road almost as strong as before the withdrawal of Philadelphia's battery, consequently New Brunswick's instrument remains silent and the operator does not hear Philadelphia call him, or Philadelphia may be sending to Trenton or New York, but New Brunswick thinking the lines free may call Philadelphia and abuse him for not answering calls promptly. This is what is happening every rainy day all over the country, but it cannot happen under the organization before you, for when Philadelphia opens his key he not only takes his own battery off, but if New York be adjusted, the battery at that end is disconnected also, only for an instant, but sufficient for the purpose, as the line is left

with absolutely no current for a moment, during which every relay on the line must respond. I will not attempt a detailed description of the operation. It is not necessary. You see that when I put in a partial earth connection between Trenton and New Brunswick, and with the adjuster at New York made inoperative by throwing the switch over to the left, New Brunswick's instrument does not respond to Philadelphia's call as it did before the rain-storm began. Trenton gets Philadelphia all right, because he is between Philadelphia and the storm. New York gets Philadelphia because his instrument is adjusted. If New Brunswick would pull up on his relay spring he would hear Philadelphia also, but he hears New York and imagines he is all right. Besides, he heard Philadelphia before the rain soaked the poles and covered the insulators with a sheet of water. Now I will throw the switch of New York adjuster over to the right. Let us see what effect it has on New Brunswick. You see his instrument works now all clear and will continue to do so no matter how hard it rains, so will all the instruments on the line. There will be no more interference and no more calling a station for hours at a time. If an operator breaks in or fails to answer promptly he can't say that his instrument was out of adjustment. The adjuster says no.

I have *talked* so long, I will say a word to you with my fingers on the electric light bulletin. The simplest telegraph in the world. Everybody can send and receive, and if the letters on the transparency be large enough, announcements may be read a mile away.

There is an electric lamp behind each letter, and all the operator has to do is to press the button of each lamp on this little keyboard. This will be a great scheme for advertising, giving election returns, etc.

I thank you sincerely for your patient attention.

PROCEEDINGS

OF THE

CHEMICAL SECTION,

OF THE

FRANKLIN INSTITUTE.

[*Stated Meeting, held at the* INSTITUTE, *Tuesday, June 18, 1889.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, June 18, 1889.

Mr. H. PEMBERTON, Jr., President, in the Chair.

Members present: Dr. S. C. Hooker, Dr Wm. H. Wahl, Prof. S. P. Sadtler, Dr. L. B. Hall, Mr. Reuben Haines, Mr. Wm. H. Bower, Mr. Fred. E. Ives, Prof. E. F. Smith, Mr. W. L. Rowland, Dr. H. W. Jayne, Mr. Lee K. Frankel, Prof. N. Wiley Thomas, Dr. Wm. H. Greene, Prof. R. L. Chase, Mr. J. H. Eastwick, Mr. A. T. Eastwick, Mr. A. W. Allen, Dr. Geo. A. Koenig, Mr. W. W. McFarlane, Mr. W. D. Weikel, Dr. Wm. C. Day and two visitors.

The President read a letter from Mr. M. Carey Lea, transmitting specimens of the various allotropic modifications of silver obtained by him, and stating that absence from the city prevented his attendance upon the meeting.

The President presented a letter from Prof. F. W. Clarke to Dr. Greene giving information in regard to the proposed formation of a National Chemical Society. He also read a copy of a letter from Professor Remsen to Prof. A. B. Prescott, reporting unfavorably upon the suggestion to make the *American Chemical Journal* the organ of the proposed National Society.

After some discussion it was voted that Dr. L. B. Hall and Dr. Geo. A. Koenig be appointed delegates to represent the Section at the next meeting of the American Association for the Advancement of Science, upon the question of the formation of a National Chemical Society. Further consideration of the subject at present was, on motion, tabled.

Dr. Hooker read his monthly report on the Philadelphia Water Supply. The report contained facts of much importance and interest, from the sanitary standpoint, particularly with reference to the Kensington pumping station, which draws its supply from the Delaware River. The paper was referred for publication. It concluded with a resolution recommending the

condemnation of the Kensington station by the FRANKLIN INSTITUTE; the motion to adopt this resolution was carried by the Section.

Mr. Fred. E. Ives then exhibited on the screen, with the projecting microscope, specimens of various crystalline substances under the influence of polarized light.

The President then read an abstract of Mr. M. Carey Lea's paper on allotropic forms of silver and exhibited specimens of the various modifications. The subject was received with much interest by the Section.

Dr. Smith and Mr. Frankel presented a paper on "Electrolytic Separations," which was referred for publication.

Dr. Greene read a letter from E. Paternò in regard to lapachic acid and its derivatives. It was referred for publication.

Adjourned.

WM. C. DAY, *Secretary.*

ERRATUM (to minutes of April meeting): The following gentlemen were elected members of the Section at the April meeting; a statement of their election was inadvertently omitted in the minutes of that meeting: Dr. L. I. Morris, Dr. Persifor Frazer, Mr. Fred. E. Ives, Mr. Theodore D. Rand.

ON THE PREPARATION AND PROPERTIES OF METALLIC MANGANESE.

BY CHAS. BULLOCK.

[*Read at the Stated Meeting of the Chemical Section, May 21, 1889.*]

The properties of manganese, like those of iron, appear to differ according to the method used in the reduction of the metal. When obtained from the oxide by heating with carbon, most authorities agree in the statement that the metal oxidizes so readily in the air that it can be preserved only under "rock oil," or in well sealed vessels. In water it is said to "oxidize rapidly, with evolution of hydrogen, and crumbles into a dark gray powder."

Cast manganese containing eight per cent. of iron is said to be unalterable in the air.

In the year 1869, some manganese prepared by me after the process of Brunner (the reduction of the chloride mixed with fluorspar, by means of sodium) was found to have as little tendency to oxidation as iron.

Repeating recently this process, pure chloride of manganese was fused in a clay crucible and poured on a stone slab, when cold it was pulverized and mixed with an equal weight of powdered fluorspar. This mixture, divided into portions of one ounce, was introduced into a French clay crucible, previously heated to redness. Eighty grains of sodium, cut into small pieces and freed from naphtha, being added to each portion, the crucible was covered, and reaction allowed to take place before adding another charge. After six ounces of the mixture had been added, the contents of the crucible was covered with fused chloride of sodium in powder, the cover replaced and the heat carried to quiet fusion. After the flux became entirely fluid, the heat was continued for ten minutes. The crucible was then removed from the fire, and after cooling the metal was found as a button at the bottom.

Three crucibles, of the capacity of eight fluid ounces each, were used at a time in a furnace without artificial blast. Care is necessary not to urge the heat too high, otherwise the crucibles will not resist the action of the fluorspar flux. The French clay crucibles were used on account of their greater freedom from iron and silica; they also resist the flux better than the Hessian, black lead or iron crucibles.

The yield of manganese under favorable circumstances, was about twenty per cent. of the chloride used.

Reduction was also tried by using fused chloride of sodium without fluorspar, the yield of metal was much less and differing in some of its properties from that obtained with the use of fluorspar. Manganate of soda was formed when sodium chloride alone was used as a flux.

Manganese thus obtained is very brittle, with a steel white fracture, so hard that a file will scarcely touch it, the edges of the fractures scratch, and almost cut, glass.

The metal retains the brightness of a fractured surface after prolonged exposure to the air, and appears not more disposed to oxidation than iron. It is entirely passive to magnetic attraction.

The specific gravity of the metal obtained when fluorspar was used was 7·072, when re-melted under fused sodium chloride, the sp. gr. rose to 7·153.

The metal obtained without the use of fluorspar was less brittle, and had a different fracture; its sp. gr. was 7·231.

Authorities differ regarding the sp. gr. of manganese, ranging it from 6·85 to 8·013.

An examination of the metal obtained, using fluorspar as a flux, showed the absence of iron, and the presence of calcium, demonstrating the reduction of some of the latter metal from the spar. This may account in a measure for the increased sp. gr. on re-melting under sodium chloride, as also the greater sp. gr. of the metal when the spar was not used. As calcium has the sp. gr. of 1·57, a small amount alloyed with the manganese would sensibly affect its gravity.*

On Aceto-Metanitrobenzoic Anhydride.

By Wm. H. Greene.

[*Read at the Stated Meeting of the Chemical Section, May 21, 1889.*]

In the reaction of acetyl chloride with silver metanitrobenzoate, L. Liebermann† claimed to have obtained metanitrobenzoyl acetic acid, a reaction which would be inexplicable and without analogy. In the course of another investigation Bischoff and Rach‡ took the opportunity of studying the action of acetyl chloride on the silver salt of *o*-nitrobenzoic acid, and found that the reaction did not take place in the sense indicated by L. Liebermann.

Under the name acetylmetanitrobenzoic anhydride, Beilstein in his *Organische Chemie* (ii, 786) describes the product supposed by Liebermann to be metanitrobenzoyl acetic acid, but the properties mentioned accord as little with those which this anhydride should exhibit, as with those which

* Sp. gr. of iron, gray, ... 7·1
" " white, ... 7·5
" " pure, ... 7·84
—*Roscoe and Schorlemmer.*

† *Berichte*, **10**, 863.

‡ *Berichte*, **17**, 2,799.

would be expected in the acid Liebermann thought he had obtained.

A preparation of this compound, according to the indications of L., by the addition of dry silver metanitrobenzoate to an excess of cold acetyl chloride, and pouring the product into water, yielded an acid fusing between 126° and 137°. 0·1866 grammes of the silver salt of this acid yielded 0·0731 grammes silver.

Ag found, 39·17 per cent. Ag calculated for nitrobenzoate, 39·42 per cent.

The acid is metanitrobenzoic, regenerated from the silver salt employed.

By the reaction of sodium metanitrobenzoate with acetyl chloride, extraction of the product with absolute ether, and evaporation of the latter, aceto-metanitrobenzoic anhydride may be readily obtained, as also by exposing silver metanitrobenzoate to vapor of acetyl chloride and extraction with absolute ether in the same manner. It crystallizes in colorless needles, fusible at 45°, and remaining in superfusion at a much lower temperature. It is insoluble in water by which it is not at once decomposed when crystallized, so that it may be washed with dilute sodium carbonate and water, and quickly dried between filter papers without change. The presence of either alcohol or water in the ether used for extraction results in the complete decomposition of all the anhydride.

On the Present Condition of the Philadelphia Water Supply. Third Monthly Report.

By Samuel C. Hooker, Ph.D.

[*Read at the Stated Meeting of the Chemical Section, June 18, 1889.*]

In my last report presented to the Section, a month ago, I recommended that the Kensington pumping station be dismantled. I did not, however, deal with the Kensington supply as fully as I now propose to do, as there appeared to be a reasonable hope that this station would only be resorted to in the immediate future in the event of an unexpected break-down occurring at one or other of the stations on the Schuylkill.

This hope, which was based upon statements emanating from the Department of Public Works, has, however, been shattered during the past month, and the importance of the subject is so great that I feel I cannot do better than devote this report entirely to its consideration.

I wish it, at the outset, to be distinctly understood that whatever is said in this report refers exclusively to the water drawn from the Delaware at the Kensington station, and does not have any bearing whatever upon the city supply as a whole. While I shall presently speak strongly against the water pumps at the Kensington Works, the experience of the past month has strengthened the fairly favorable conclusion to which I had previously come and which has been already expressed in my last two reports, regarding the actual quality, aside from muddiness, of the Schuylkill water, which, as is well known, forms the bulk of the city supply.

The Kensington district is at present supplied from the Delaware at Kensington, from the Delaware at Lardner's Point, and from the Schuylkill.

Two thirty-inch mains, the one conveying water from the Wentz Farm reservoir, the other from the Schuylkill, make

connection with the Lehigh basin, which supplies the district. The Kensington pump also discharges into the Lehigh basin.

In spite of all efforts which can be made by the Water Department, under existing circumstances, the water carried through the two mains just referred to, from the Schuylkill and from the Wentz Farm basin, is not sufficient for the requirements of the neighborhood, and consequently the level in the Lehigh basin gradually sinks, pressure diminishes, and finally complaint of short supply reaches the Department. Nothing remains but to start up the pump at Kensington, and to continue drawing water from the Delaware until the reservoir is again filled. I thoroughly believe that the necessity of abandoning the Kensington station is fully realized by the Chief Engineer of the Water Department, but he is powerless to cause this to be done until some adequate provision is made for meeting the requirements of the district.

The bulk of the water drawn at the Kensington Works is supplied to the sixteenth, seventeenth, eighteenth, nineteenth and thirty-first wards. This district, as is well known, is the unhealthiest portion of the city. That the water is in a great measure responsible, there can be no doubt; to say that it is entirely responsible, might possibly be stating the case too strongly.

It is proposed to carry a forty-eight-inch main from the Schuylkill, in place of the thirty-inch main now existing, but this cannot be done without money, and until the sum necessary for this purpose is appropriated, pumping from the Delaware at Kensington must continue to a greater or less extent.

For years past the money which has been placed at the disposal of the Department has been very far short of that required for its imperative needs, and this state of affairs promises to continue unless some action is taken by the general public in asserting its rights and insisting that they shall be respected.

Whatever difference of opinion may exist regarding the wholesomeness of the Schuylkill, there is absolutely none

possible regarding that of the Delaware at Kensington, and it cannot be too strongly insisted that this foul, sewage-polluted water shall be no longer used for city supply, even though its poisonous and filthy character is partially or entirely disguised by admixture with large volumes of water from the Schuylkill and from Lardner's Point.

It is simply impossible for the sewage discharged into the Delaware, in the neighborhood of the Kensington Works, to be in any degree purified before it is taken up by the pump and distributed to the helpless population of the sixteenth, seventeenth, eighteenth, nineteenth and thirty-first wards. What wonder, then, that the Kensington district is a very hot-bed of disease in this city?

For nearly thirty years, this water from the Delaware at Kensington has been repeatedly condemned as *unfit for use* by Health Boards, by the engineers of the Water Department, by the experts who have examined into the matter, by every one, in fact, whose scientific knowledge has been sufficient to enable a clear estimate to be formed of the danger of supplying this sewage-saturated water to the community. Common sense rebels against it, the records of the Health Office silently protest against it, and yet for thirty years this pumping from the Delaware at Kensington, from a station which ought never to have been established, has been continued.

For a great number of years it has been the purpose of the various administrations of the city to abandon the Kensington Works, and it may be well to inquire how it happens that in spite of such good intentions these works still exist. The recommendations suggested by the various engineers of the Water Department, if carried out promptly at the time they were made, unquestionably would have enabled the Kensington station to fall into disuse, but unfortunately they were allowed to remain so long unacted upon, that when finally put into effect, instead of being able to supplant the Delaware supply for which they were originally devised, they were only able to meet the additional requirements of the district, due to its growth in the meantime.

It has been argued that the quantity of water pumped at Kensington is insignificantly small compared with the total supply of the city. So much the better; but instead of being a good reason for the water to be tolerated, it makes substitution of better water all the easier, and therefore all the more to be insisted upon.

Let me now refer to a few extracts from the reports of the Board of Health. The first is taken from the report for the year 1862, p. 13:

"One of the most serious and aggravated nuisances which has attracted the attention of the Board was the water supplied by the Kensington Works. After a careful investigation, based upon personal observation, as well as the experience of several physicians practising, and the analysis of a practical chemist, the Board, in May last, declared the water therefrom furnished to be a nuisance, prejudicial to public health, and so notified Councils. * * * *We are of the opinion that the only permanent remedy will be the total abandonment of the Kensington Works.*"

In the report of the Board of Health for 1866, p. 10, occurs the following:

"*All things considered* [the water] *is a sanitary evil of so dangerous a nature to the health of the inhabitants of those wards through which it is distributed, as to demand at the hands of Councils its immediate disuse.*" (The Chief Engineer, after an allusion to the alterations since made, says: "*I regard it as certain that the supplying of pure, or in any considerable degree suitable, water, for domestic purposes, from the river Delaware at the location of the Kensington Water Works, is impossible.*")

"Notwithstanding the improvement in the induction passage from the river to the pumps there has been no improvement in the water itself, nor can there ever be whilst the present supply of Kensington water is derived from the river Delaware at the present location. It will be evident to every disinterested visitor to the Kensington Water Works that a supply of pure water is impossible. The sewers opening into the river Delaware discharge their contents at a rate of an average of about 13,000,000 gallons daily, which necessarily includes every description of

impure and refuse matter from the city, and of late years this impurity is much increased by the construction and connection of numerous water-closets with the sewers, from both public and private dwellings. A further deterioration necessarily occurs from the emptying of Gunner's Run and Cohocksink Creek into the Delaware, together with the large amount of human and other offal deposited in the river at Richmond. * * *

"The action of the tides, the movements of steamboats and the general traffic on the river, keep in suspense and carry a large portion of the impurities from the sewers from Gunner's Run and the Cohocksink Creek far beyond the present mouth of the induction tube at the end of the wharf. * * * When we know from our bills of weekly mortality that out of 277 deaths from *cholera Asiatica*, 132 (or 47 per cent.) have occurred in those wards supplied with the Kensington Delaware water, we think we shall be borne out in the opinion that the prevalence of the disease in those districts is not only occasioned by the use of the water as a prominent cause, but that it is so deteriorated in quality as to make it unfit for domestic purposes, dangerous to health and life, and therefore your committee would declare it to be a nuisance prejudicial to health, and would offer the following:

"*Resolved*, That the Kensington water supply as taken from the Delaware is a nuisance prejudicial to public health, and that Councils be urged by this Board to discontinue the supply at the earliest practicable moment, as the only remedy for the removal of the nuisance and the protection of the health of the district supplied therewith."

If this was the condition of affairs nearly twenty-five years ago, with how much more force do these arguments apply at the present time, when the amount of the sewage flowing into the river Delaware in the neighborhood of the Kensington pumping station has been ever on the increase.

The following extract is taken from the report for 1871, p. 28:

"The immense quantity of filth of every description deposited in the river from the common sewers, estimated

at over 13,000,000 gallons daily, and decomposing organic matter always floating about the wharves, which is carried up and down the river front by the tidal currents, and constantly agitated by the general traffic upon the river, must of necessity have a deleterious effect upon the water, even at a distance from the shore. * * * *In the opinion of this Board, water taken from the Delaware River at any point along the city front is totally unfit for domestic use.*"

Again, in the report of the Board of Health to the Mayor, for 1882, p. 13:

"The water pumped at the Kensington Works is unfit for domestic use, and this station should be abandoned." * * *

"This recommendation has frequently been made before, but it has never been heeded. It would appear reasonable to infer that the high death rate in the wards supplied with this water has some connection with the fact above stated."

From the report of Chief Engineer, Philadelphia Water Department, for 1883, p. 45:

"The Delaware, along the city front, is the recipient sooner or later, of the sewage refuse and street washings of a city area occupied by a population probably exceeding 800,000. These waste matters are borne up and down by the tides and usually pass and repass the city several times before taking their final departure. Under these circumstances, whatever may be the volume of the stream, it is by necessity polluted and is not suitable for immediate and habitual daily use.

"*In especial is the vicinity of the Kensington station marked by an accumulation of the foulest materials.*

"Its central position insures its getting the full benefit of the city's sewage, and in addition the Aramingo Canal—an open sewer of large dimensions and choked with filth—discharges in its immediate vicinity. The water taken thence is utterly unfit for human consumption."

These extracts might be indefinitely multiplied, chemical analyses might be quoted, health statistics dwelt upon —but to what purpose? The evidence I have already

presented seems to me so overwhelming that it would gain nothing in force by such additional arguments.

If the arguments against the Kensington station carried only one-tenth of the weight of those actually existing, there would still be sufficient reason to require its immediate removal.

The existence of the Kensington station through the past thirty years has been a sufficient disgrace to the city. Let it be tolerated no longer. Let public opinion express itself strongly, unmistakably. Let the newspapers of this city unceasingly agitate the matter. Let the learned and other societies engage in the contest. Let individual influence be exercised. The Kensington pumping station will then exist only as a memory of the past, to be long remembered for the desolation it has wrought in many families, but not to be feared for that which it also threatens, as at the present time and in the future.

Let us not be satisfied with any half measures, for so long as the Kensington pump remains it will be liable to be put into operation at any time. The station must be completely dismantled and pumping rendered absolutely impossible in the future.

Finally, let me ask you gentlemen, who represent the most prominent of the chemists of this city, and who by your attainments and knowledge are especially qualified to give judgment on this most important subject, unanimously to recommend to the INSTITUTE the passage of the following resolution:

"That the FRANKLIN INSTITUTE most strongly condemns the use of the Delaware water at Kensington for city supply and that it urges Councils to take immediate steps to render possible the abandonment of the Kensington pumping station."

By passing this resolution without a dissenting vote, I feel that you will confer a great benefit on the city and add to the good work for which the FRANKLIN INSTITUTE has been noted in the past.

ABSTRACTS.

ALLOTROPIC FORMS OF SILVER. BY M. CAREY LEA.—In the *American Journal of Science* for June, 1889, Mr. M. Carey Lea has a paper on "Allotropic Forms of Silver." His experiments show that metallic silver may exist in a perfectly soluble form, dissolving easily and abundantly in water. Starting from this, it may show all degrees of solubility down to absolute insolubility, still, however, existing in an allotropic form and quite distinct from normal or ordinary silver. The solutions formed are as perfect as those of any other soluble substance.

There are three modifications of this allotropic form:

A. The Soluble Form.—A solution of ferrous citrate (or of a mixture of ferrous sulphate and sodic citrate) is added to a solution of silver nitrate, the mixture well stirred and allowed to stand for ten or fifteen minutes. The lilac-blue precipitate is then washed on a filter with a five per cent. or ten per cent. solution of nitrate, citrate or sulphate of ammonia or of soda, in any of which salts it is perfectly insoluble. The color changes on washing to a deep blue. To remove the iron as far as possible, repeated solution in water and re-precipitation by ammonic nitrate is necessary, the ammonia salt being finally displaced by washing with ninety-five per cent. alcohol. The aqueous solution of this allotropic form of silver is blood-red. Optical examination proved it to be a true solution, and not a mere suspension of a finely-divided precipitate. "The inference, therefore, seems to be very strong that there exists an allotropic form of silver, freely soluble in water. This is a property so exceptional in a metal that I have admitted it with much hesitation. The principal arguments are as follows:

"The contents of silver in the various products was very carefully, and, I believe I may say, quite accurately determined; it was extremely high, always above ninety-seven per cent. As already remarked, this virtually excludes the presence of all other elements, except hydrogen and possibly oxygen. These elements were carefully searched for, but their presence could not be detected. To suppose that we had to do with a mixture in which some compound of silver was mixed with metallic silver was not possible, for, as the whole was soluble, we should still have to admit the solubility of silver.

"We have, consequently, to deal with a substance containing over ninety-seven per cent. of silver, and neither hydrogen nor oxygen in combination with it—the remaining two or three per cent. fully accounted for by ferric oxide and citric acid, determined as present as accidental impurity; the substance itself readily amalgamating with mercury by simple friction, nevertheless abundantly soluble in water. If I had been able to find any other explanation for these facts, without admitting the solubility of silver, I should have adopted it. But none presented itself.

"Whether, in solution, it exists as a hydrate—that is, in more intimate combination with one or more equivalents of water—cannot be said with entire certainty; but the easy amalgamation with mercury seems hardly to favor that view."

B. The Insoluble Form.—The first and soluble modification of the allotropic form of silver was produced, as shown above, by precipitating by an alkaline nitrate, citrate or sulphate. The second and insoluble form is produced by precipitating by magnesium, cupric, ferrous or nickel sulphate, or by potassium bichromate or ferrocyanide, or by barium nitrate, or even by silver nitrate. If any one of these salts is employed in extremely dilute solutions as the precipitant, the resulting precipitate is insoluble in water. If it is treated with a concentrated solution of any of the above salts, it becomes, strange to say, once more soluble in water.

This insoluble form is best seen when applied as a thin film to paper by a brush, enough water being added to give it a paste-like consistency. This film is of a greenish color, blue in certain lights, yellow in others; the yellow being the more pronounced in proportion as the washing is thorough. On drying, the lustre is remarkable, a perfect mirror being obtained. This insoluble form, after drying at 100°C., contained 97·96 per cent. silver. "The remaining 2·04 per cent. consisted of ferric oxide and citric acid."

C. The gold-yellow and copper-colored silver is produced by the reduction of silver tartrate by ferrous tartrate. The resulting precipitate is first glittering red, then changes to black, and on the filter has a beautiful bronze appearance. The silver nitrate is entirely converted into this allotropic form, which is insoluble in water, and dries to lumps exactly resembling highly-polished gold. A paste of it extended over glazed paper, dries with the splendid lustre of gold leaf. The percentage of silver present = 98·75. Occasionally, a spontaneous reversion to normal silver occurs, the latter being extremely beautiful and resembling the finest frosted jeweler's silver.

All of the above allotropic forms have the following properties in common:

(1) *That of drying with their particles in optical contact* and consequently forming films and mirrors as above described.

(2) *The halogen reaction.* When any of the films on paper are dipped in a solution of sodium hypochlorite of ferric chloride, or of iodine dissolved in potassium iodide, magnificent intense shades with metallic reflections are produced. They often remind one of the color of a peacock's tail and are caused by interference. This characteristic forms one of the principal reactions for distinguishing allotropic silver from ordinary silver.

(3) The stronger acids, even when much diluted, instantly convert the allotropic form of silver into normal gray silver, without the slightest evolution of gas.

(4) All of these allotropic forms are easily reduced to an impalpable powder. In addition to these four points, Mr. Lea states that all of his products readily form an amalgam with mercury.

Mr. Lea has been at work upon this subject for over three years. He expects to have a second paper in the July number of the *American Journal of Science*. The properties of these allotropic forms of silver discovered by him are certainly extraordinary. Indeed, any *one* of the properties of these products is remarkable. It is remarkable that silver can be obtained in a form having all the color and brilliancy of gold. It is remarkable that while having thus the lustre of a metal and also the metallic property of amalga-

mating with mercury, it still is friable and easily reduced to powder. But most remarkable of all is the fact that it is freely and abundantly soluble in water. Certainly this property is unique. In the entire list of metals there is none that possesses anything like it.

Mr. Lea's investigations have opened a most interesting field of research, that will probably produce results of the highest importance. P.

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[*Proceedings of the Stated Meeting, held Wednesday, June 19, 1889.*]

HALL OF THE FRANKLIN INSTITUTE,
WEDNESDAY, June 19, 1889.

JOSEPH M. WILSON, president, in the Chair.

Present, 106 members and twelve visitors.

Additions to membership since last report, thirty-four.

The Secretary reported the resignations of Mr. C. W. HOWARD, Prof. WM. D. MARKS and Mr. PEDRO G. SALOM as members of the Committee on Science and the Arts.

The resignations were accepted and a ballot was ordered, to fill the vacancies, which resulted in the election of

Dr. W. C. HEAD, in place of Mr. HOWARD.

Mr. JOHN HALL, in place of Prof. MARKS, and

Prof. ARTHUR BEARDSLEY, in place of Mr. SALOM.

Mr. WM. L. BOSWELL was appointed as a delegate to the Universal Exposition, in Paris, to report on Fire-proof Building Construction, and on Means and Appliances for Extinguishing Fires, and the President and Secretary were authorized to have prepared a suitable document certifying the fact, over their signatures and the seal of the INSTITUTE.

Dr. ROBERT GRIMSHAW, of New York, gave a description of Bailey's Improved Adjustable-Hub Pulleys, and of an improved Cotton Compress. (Referred for publication.)

Mr. T. G. ELLSWORTH, of New York, gave a description of the Knudson-Ellsworth Acoustic Telephone, exhibiting the instrument in operation. (Referred for investigation and report to the Committee on Science and the Arts.)

Mr. S. LLOYD WIEGAND gave some account of the successful use of steel spheres for reducing the friction of journals. These were made upon the Simons Rolling Machine, previously described in the JOURNAL.

Dr. S. C. HOOKER read a brief paper, condemning the use of the Delaware River water, at Kensington, as unfit, by reason of its serious contamination with sewage, for drinking, and urging the abandonment of the Kensington pumping station.

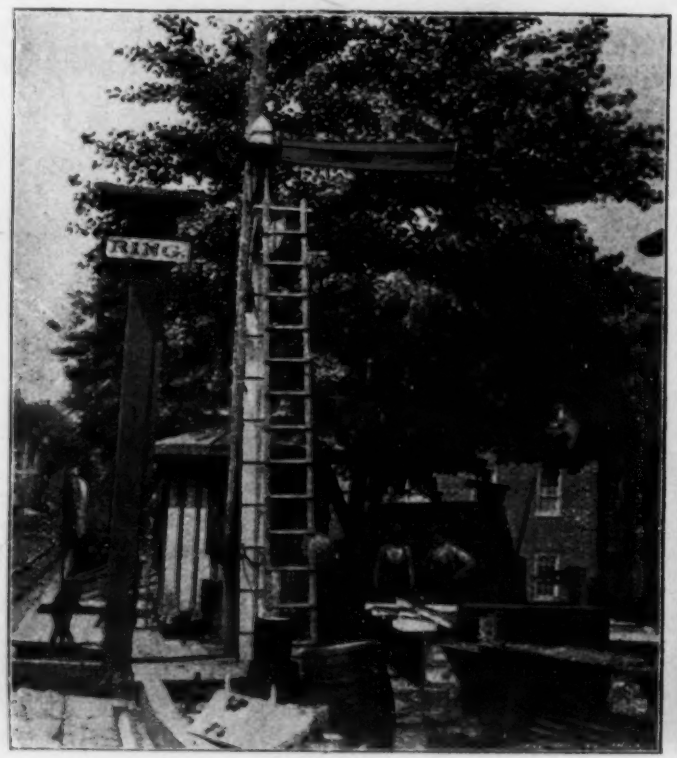
The paper embodied the accompanying resolution of the CHEMICAL SECTION, "That the FRANKLIN INSTITUTE most strongly condemns the use of the Delaware water, at Kensington, for city supply, and respectfully urges Councils to take immediate steps to render possible the abandonment of the Kensington pumping station."

The resolution was the subject of some debate, and was thereupon adopted.

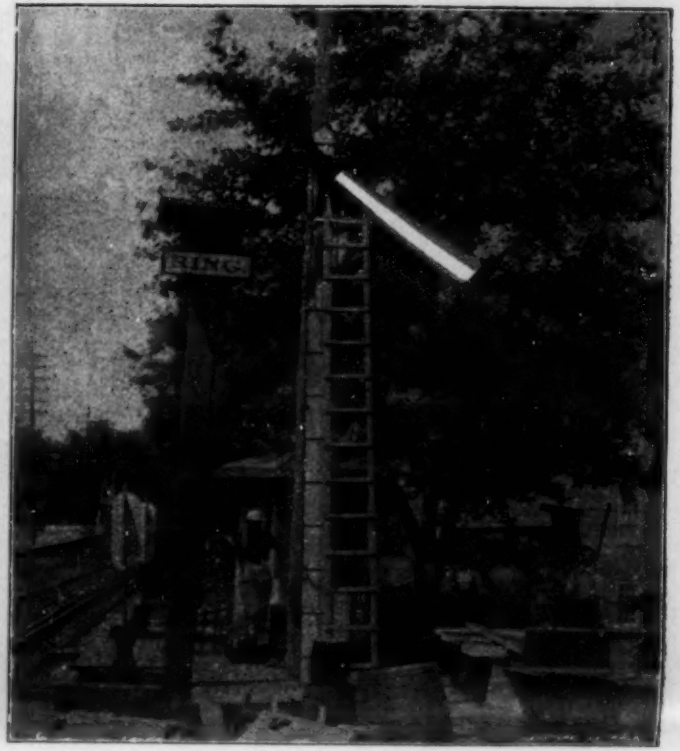
Mr. W. F. JENNINGS exhibited on the screen a series of photographic views of the recent inundations along the line of the Pennsylvania Railroad, and the Secretary showed a series of views, exhibiting the destruction wrought by the deluge in the Conemaugh Valley.

Adjourned.

WM. H. WAHL, *Secretary.*



Danger.—Day.

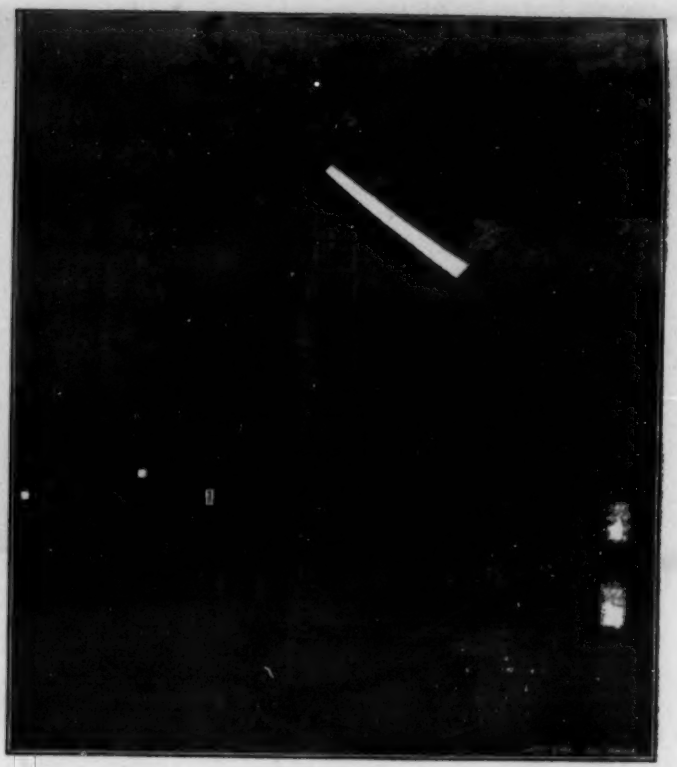


Safety.—Day.

Danger.—Day.

Safety.—Day.

Danger.—Night.



Safety.—Night.